National Park Service
U.S. Department of the Interior

Bighorn Canyon National Recreation Area
Montana/Wyoming

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Personal Watercraft Use Environmental Assessment

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Personal Watercraft Use Environmental Assessment

April 2003

SUMMARY

Bighorn Canyon National Recreation Area (Bighorn Canyon) was established in 1966 "In order to provide for public outdoor recreation and use and enjoyment of the Yellowtail Reservoir and lands, adjacent thereto in the States of Wyoming and Montana, by the people of the United States and for preservation of the scenic, scientific, and historic features contributing to public enjoyment of such lands and waters" (16 USC§ 460t). The most direct route to the southern end of Bighorn is via Montana state road 310 from Billings, Montana or U.S. Highway 14A from Sheridan, Wyoming.

The purpose of and the need for taking action is to evaluate a range of alternatives and strategies for managing personal watercraft (PWC) use at Bighorn Canyon to ensure the protection of park resources and values while offering recreational opportunities as provided for in the national recreation area's enabling legislation, purpose, mission, and goals. Upon completion of this process, in accordance with the *National Environmental Policy Act* (NEPA), the National Park Service (NPS) may either take action to adopt special regulations to manage PWC use, or it may not reinstate PWC use at this park unit.

BACKGROUND

More than one million personal watercraft are estimated to be in operation today in the United States. Sometimes referred to as "jet skis" or "wet bikes," these vessels use an inboard, internal combustion engine powering a water jet pump as its primary source of propulsion. They are used for enjoyment, particularly for touring and maneuvers such as wave jumping, and they are capable of speeds in the 60 mile-per-hour (mph) range. The Personal Watercraft Industry Association (PWIA) believes that through the year 2002, most PWC output is between 155 and 165 horsepower (PWIA 2002b). Personal watercraft were once the fastest growing segment of the boating industry and represented over one-third of total sales. National PWC ownership increased every year between 1991 and 1998; the rate of annual increase peaked in 1994 at 32% and dropped slightly in 1999, 2000, and 2001. While PWC use remains a relatively new recreational activity, it has occurred in 32 of the 87 national park system units that allow motorized boating.

After studies in Everglades National Park showed that PWC use resulted in damage to vegetation, adversely impacted shorebirds, and disturbed the life cycles of other wildlife, the National Park Service prohibited PWC use by a special regulation at the park in 1994. In recognition of its duties under its *Organic Act* and NPS *Management Policies* (NPS 2000c), as well as increased awareness and public controversy about PWC use, the National Park Service subsequently reevaluated its methods of PWC regulation. Historically, the National Park Service had grouped personal watercraft with all vessels; thus, PWC use was allowed when the unit's Superintendent's Compendium allowed the use of other vessels. Later, the National Park Service closed seven units to PWC use through the implementation of horsepower restrictions, general management plan revisions, and park-specific regulations such as those promulgated by Everglades National Park.

In May 1998, the Bluewater Network filed a petition urging the National Park Service to initiate a rulemaking process to prohibit PWC use throughout the national park system. In response to the petition, the National Park Service issued an interim management policy requiring superintendents of parks where PWC use can occur but had not yet occurred to close the unit to such use until the rule was finalized. The National Park Service envisioned the servicewide regulation as an opportunity to evaluate impacts from PWC use before authorizing the use. On March 21, 2000, the National Park Service issued a regulation prohibiting PWC use in most units and required 21 units to determine the appropriateness of continued PWC use.

In response to the PWC final regulation, Bluewater Network sued the National Park Service, challenging NPS's decision to allow continued PWC use in 21 units while prohibiting PWC use in other units. In response to the suit, the National Park Service and the environmental group negotiated a settlement. Each park desiring to continue long-term PWC use must promulgate a park-specific special regulation in 2002. In addition, the settlement stipulates that the National Park Service must base its decision to issue a park-specific special regulation to continue PWC use through an environmental analysis conducted in accordance with NEPA. The NEPA analysis at a minimum, according to the settlement, must evaluate PWC impacts on water quality, air quality, soundscapes, wildlife, wildlife habitat, shoreline vegetation, visitor conflicts, and visitor safety.

As the settlement deadline approached and the park units were preparing to prohibit PWC use, the National Park Service, Congress, and PWC user groups sought legal methods to keep the parks open to this activity. However, no method was successful. After November 6, 2002, Bighorn Canyon was closed to PWC use. If, as a result of this environmental assessment, an alternative is selected that would allow PWC use to be reinstated, then a special regulation to authorize that use will be drafted.

ALTERNATIVES CONSIDERED

This environmental assessment evaluates three alternatives concerning the use of personal watercraft at Bighorn Canyon.

- Alternative A – Reinstate PWC Use under a Special Regulation as Previously Managed.
- Alternative B – Reinstate PWC Use under a Special Regulation with Additional Management Prescriptions.
- No-Action Alternative – Allow no PWC use. No special rule would be promulgated.

Based on the environmental analysis prepared for PWC use at Bighorn Canyon, alternative B is considered the environmentally preferred alternative because it would best fulfill park responsibilities as trustee of this sensitive habitat; ensure safe, healthful, productive, and aesthetically and culturally pleasing surroundings; and attain a wider range of beneficial uses of the environment without degradation, risk to health or safety, or other undesirable and unintended consequences.

ENVIRONMENTAL CONSEQUENCES

Impacts of the three PWC management alternatives were assessed in accordance with *Director's Order #12: Conservation Planning, Environmental Impact Analysis and Decision-Making.* The *Director's Order #12 Handbook* requires that impacts to park resources be analyzed in terms of their context, duration, and intensity. It is crucial for the public and decision-makers to understand the implications of those impacts in the short and long term, cumulatively, and within context, based on an understanding and interpretation by resource professionals and specialists.

To determine impacts, methodologies were identified to measure the change in park resources that would occur with the implementation of the PWC management alternatives. Thresholds were established for each impact topic to help understand the severity and magnitude of changes in resource conditions, both adverse and beneficial.

Each PWC management alternative was compared to a baseline to determine the context, duration, and intensity of resource impacts. The baseline, for purposes of impact analysis, is the reinstatement of PWC use and previous management projected over the next 10 years (alternative A).

Table A summarizes the results of the impact analysis for the impact topics that were assessed in the "Environmental Consequences" chapter. The analysis considered a 10-year period (2002–2012).

No park resources or values would be impaired by implementing any of the alternatives being considered.

TABLE A: SUMMARY OF THE IMPACT ANALYSIS

Impact Topic	Alternative A: Reinstate PWC Use under a Special Regulation as Previously Managed	Alternative B: Reinstate PWC Use under a Special Regulation with Additional Management Prescriptions	No-Action Alternative: Allow No PWC Use
Water Quality	PWC use impacts: Negligible long-term adverse effects in 2002 and 2012 from personal watercraft and would be well below ecotoxicological benchmarks and criteria. Adverse water quality impacts from personal watercraft from benzo(a)pyrene, benzene and MTBE based on human health (ingestion of water and fish) benchmarks would be negligible in both 2002 and 2012. Cumulative impacts: Negligible long-term adverse effects in 2002 and 2012 from water vessels and would be well below ecotoxicological benchmarks and criteria. Negligible, adverse and long-term for benzo(a)pyrene, benzene and MTBE.	PWC use impacts: Same as alternative A. Closure of the South Narrows area would not measurably change water quality impacts. Cumulative impacts: Cumulative impacts would be negligible for benzo(a)pyrene, benzene and MTBE.	PWC use impacts: Beneficial impacts from elimination of PWC use. Cumulative impacts: Cumulative impacts would be negligible adverse in 2002 and 2012 for all ecotoxicological and human health benchmarks.
Air Quality	PWC use impacts: Negligible adverse impacts related to CO, PM_{10}, HC and NO_x. The risk from PAH would also be negligible adverse. In 2012, there would be an increase in NO_x emissions and a decrease in emissions of the other pollutants; impact levels for these pollutants would remain the same as in 2002. Cumulative impacts: Cumulative impacts would be negligible adverse for PM_{10}, HC and NO_x, and minor adverse for CO in 2002 and 2012. CO and NO_x emissions increase from 2002 to 2012 because of increased boating activity and cleaner engines that have higher CO and NO_x emissions. Greater reduction in HC emissions result in a beneficial impact to regional ozone concentrations and maintain or	PWC use impacts: Same impacts to human health as alternative A. Cumulative impacts: Cumulative adverse impacts from PWC and other boating emissions at Bighorn Canyon would be minor for CO and negligible for PM_{10}, HC, and NO_x in 2002. In 2012, impacts would remain at 2002 levels although a beneficial impact to regional ozone emissions occurs due to a reduction in HC emissions. This alternative would maintain or improve existing human health air quality conditions, with future reductions in PM_{10} and HC emissions due to improved emission controls. PWC contribution to emissions of HC are estimated to be 14% of the cumulative boating emissions in 2002 and 2012.	PWC use impacts: Beneficial impacts on human health relative to the other alternatives for CO, HC, PM_{10} and NO_x for the years 2002 and 2012, because PWC emissions would be eliminated. Risk from PAH would be negligible in 2002 and 2012. Cumulative impacts: Cumulative adverse impacts to human health from airborne pollutants in 2002 would be negligible for all four pollutants. In 2012, adverse impacts remain negligible for PM_{10}, HC and NO_x, while the impact for CO would increase from negligible to minor. There would be increased CO emissions and slightly increased NO_x emissions in 2012. Similar to other alternatives, with improved emission controls, future

TABLE A: SUMMARY OF THE IMPACT ANALYSIS

Impact Topic	Alternative A: Reinstate PWC Use under a Special Regulation as Previously Managed	Alternative B: Reinstate PWC Use under a Special Regulation with Additional Management Prescriptions	No-Action Alternative: Allow No PWC Use
	improve existing air quality conditions, with future reductions in PM_{10} and HC emissions continuing beyond 2012 in PM_{10} and HC emissions due to improved emission controls. PWC emissions of HC are estimated to be 14% of the cumulative boating emissions in 2002 and 2012.		emissions of HC and PM_{10} would continue to decline. Reductions in HC emissions results in beneficial impact to regional ozone levels. Risks from PAH would be negligible in 2002 and 2012.
Air Quality Related Values from PWC Pollutants	PWC use impacts: Negligible adverse impacts to air quality related values would occur from personal watercraft in 2002 and 2012 under alternative A. Cumulative impacts: In both 2002 and 2012 negligible adverse impacts. Beneficial effects to ozone levels in 2012 resulting from the expected reduction in HC emissions from new engine technology.	PWC use impacts: Same as alternative A because additional PWC management prescriptions would not noticably affect personal watercraft emissions. Cumulative impacts: Same as alternative A.	PWC use impacts: Same as alternative A. Cumulative impacts: Same as alternative A.
Soundscapes	PWC use impacts: Minor to moderate adverse impacts over the short and long-term at most locations on Bighorn Lake and immediate surrounding area. Impact would be related to the number of personal watercraft operating as well as the sensitivity of other visitors. Cumulative impacts: Minor to moderate adverse impacts over the short and long-term because these sounds would be heard occasionally throughout the day, and may predominate on busy days during the high use season.	PWC use impacts: Negligible to moderate adverse impact. Minor and moderate short-term PWC noise impacts would occur in the areas of the national recreation area north of the Narrows. Could periodically be longer-term at shoreline areas on the very high use days, where motorized noise may predominate off and on for most of the day. Cumulative impacts: Minor to moderate because these sounds would be heard occasionally throughout the day, and may predominate on busy days during the high use season.	PWC use impacts: Beneficial effect due to elimination of PWC use. Cumulative impacts: Minor to moderate adverse in the short and long-term.
Wildlife and Wildlife Habitat	PWC use impacts: Negligible to minor adverse impacts on fish, waterfowl, and other wildlife. No perceptible changes in wildlife populations or their habitat community structure. Any impacts to fish, wildlife and respective habitats would be temporary and short term. Cumulative impacts: Short-term, minor to moderate adverse effects. Fluctuations in water level would cause short- to long-term minor to moderate adverse impacts to fish, and beneficial or adverse impacts to riparian and wetland areas	PWC use impacts: Beneficial impacts to wildlife due to the decreased noise and disturbance from PWC. Although reduced, impacts to wildlife and wildlife habitat would remain adverse negligible to minor in 2002 and 2012. All wildlife impacts from personal watercraft would be temporary and short term. Cumulative impacts: Adverse impacts would be minor to moderate as under alternative A. Lake level fluctuations would also contribute to cumulative	PWC use impacts: Beneficial impacts on wildlife and wildlife habitat. Cumulative impacts: Adverse impacts would be short-term, minor to moderate due to visitor activities and short to long-term, minor to moderate from lake level fluctuations. The contribution of PWC use to overall adverse impacts to wildlife and wildlife habitat would be eliminated.

TABLE A: SUMMARY OF THE IMPACT ANALYSIS

Impact Topic	Alternative A: Reinstate PWC Use under a Special Regulation as Previously Managed	Alternative B: Reinstate PWC Use under a Special Regulation with Additional Management Prescriptions	No-Action Alternative: Allow No PWC Use
	that provide habitat for wildlife.	adverse impacts through minor to moderate levels of short to long-term habitat disturbance.	
Threatened, Endangered, or Special Concern Species	PWC use impacts: May affect, but is not likely to adversely affect, the following species with federal or state protection status: bald eagle, Rocky Mountain bighorn sheep, American peregrine falcon, Townsend's big-eared bat, northern leopard frog, or persistent sepal yellowcress. No effect to all other federal or state listed species. The identified special status species are either not permanent residents and not present during times of PWC use, are not usually accessible, are generally acclimated to human activity, or do not have preferred habitat in the areas used by personal watercraft. Cumulative impacts: May affect, but would not likely adversely affect, special status species, due to lack of species occurrences and access to their habitats.	PWC use impacts: May affect, but would not likely adversely affect, special status species including Rocky Mountain bighorn sheep, American peregrine falcon, Townsend's big-eared bat, or northern leopard frog. Potential for impacts would be reduced relative to alternative A due to the decreased area of allowed PWC use and increased PWC user education efforts. Potential effects to the bald eagle and persistent sepal yellowcress eliminated by the closure of the South Narrows to PWC use and no effects from PWC would occur to these species under this alternative. There would be no PWC-caused effects to all other federal or state listed species. Cumulative impacts: Impacts not likely to substantially increase since PWC numbers are not expected to increase substantially. All impacts to special status species would be temporary and short term. Cumulative impacts may affect but would not be likely to adversely affect special status species and would result from lake level fluctuations as well as visitor activities that are concentrated mostly in developed areas rather than in habitat for special status species.	PWC use impacts: Elimination of PWC related effects to special status species and habitat relative to alternatives A and B. Cumulative impacts: Similar and overall effects would remain the same as other alternatives. The no-action alternative may affect, but is unlikely to affect special status species in the national recreation area.
Shorelines and Shoreline Vegetation	PWC use impacts: Negligible short-term adverse effects on shoreline vegetation Cumulative impacts: Adverse impacts would be negligible to minor and short-term. Lake level fluctuations would potentially have minor to moderate adverse impacts in the Yellowtail Wildlife Habitat area.	PWC use impacts: Beneficial impacts to sensitive shoreline vegetation in the southernmost portion of the national recreation area over the short and long term as potential for adverse impacts would be reduced. Cumulative impacts: Adverse impacts from all watercraft and other visitor activities would remain negligible to minor, while impacts from lake level fluctuations would remain minor to moderate.	PWC use impacts: Same as alternative A. Cumulative impacts: Non-PWC watercraft activity and other visitor uses would continue, and would be negligible to minor. Lake fluctuations due to drought or lake operations would have minor to moderate adverse impacts on sensitive shoreline vegetation. PWC contribution to these impacts would be eliminated.

TABLE A: SUMMARY OF THE IMPACT ANALYSIS

Impact Topic	Alternative A: Reinstate PWC Use under a Special Regulation as Previously Managed	Alternative B: Reinstate PWC Use under a Special Regulation with Additional Management Prescriptions	No-Action Alternative: Allow No PWC Use
Visitor Use and Experience	PWC use impacts: Negligible to minor adverse impacts in the short and long term. Long-term, minor to moderate adverse impacts on those visitors desiring natural quiet. Negligible adverse impacts on other boaters due to increased congestion at popular boat launches. Most experience negligible to minor adverse effects and would be satisfied with experiences. Cumulative impacts: Short- and long-term, negligible adverse impacts.	PWC use impacts: Negligible adverse impact on most PWC users since with closure of South Narrows. Negligible adverse impacts for other boaters and all shoreline users north of the South Narrows and beneficial impacts south of the South Narrows. Cumulative impacts: Long-term, negligible adverse impacts.	PWC use impacts: Beneficial impact on the experiences of most non-PWC using visitors to the recreation area. Long term, minor, and adverse Impacts on PWC users. Cumulative impacts: Short- and long-term negligible impacts.
Visitor Conflicts and Safety	PWC use impacts: Negligible to minor adverse impacts over the short and long term. Conflicts mostly at Horseshoe Bend and Ok-A-Beh. Conflicts at other locations negligible because use is lower. Cumulative impacts: Negeligible adverse for all user groups in the short and long term. Most visitors experience negligible to minor adverse effects and would be satisfied with experiences.	PWC use impacts: Beneficial impacts on visitor conflict and safety goals south of the South Narrows. North of the South Narrows impacts on visitor conflict and safety goals would be negligible adverse. Cumulative impacts: Negligible to minor adverse for all user groups in the short and long term, particularly near the high use areas.	PWC use impacts: Beneficial impact on the visitor conflict and safety goals of swimmers, other boaters, and all other visitors. Cumulative impacts: Negligible adverse for all user groups in the short and long term.
Cultural Resources	PWC use impacts: Minor adverse impacts over the short and long term. Cumulative impacts: Cumulative impacts minor to major adverse over the short and long term, due to the number of visitors and the potential for illegal collection or destruction.	PWC use impacts: Similar to alterantive A beneficial impacts associated with closure of South Narrows. Cumulative impacts: Same as alternative A.	PWC use impacts: Beneficial impacts over the short and long term with the ban on PWC use. Cumulative impacts: Same as alternative A.
Socioeconomic Effects	No change from current conditions. No measurable impacts on the local or regional economy.	Same as alternative A: negligible impacts.	Major, short- and long-term, adverse impacts on PWC users. No measurable impacts on the local or regional economy.
National Recreation Area Management and Operations	PWC use impacts: Moderate adverse impacts on park operations (more staff, funding, equipment, and educational material to regulate use).	PWC use impacts: Similar to alternative A, plus educational supplies needed.	PWC use impacts: Negligible adverse impacts on park operations with no additional staff, funding, or equipment.

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PURPOSE OF AND NEED FOR ACTION

INTRODUCTION

Bighorn Canyon National Recreation Area (Bighorn Canyon) was established in 1966 "In order to provide for public outdoor recreation and use and enjoyment of the Yellowtail Reservoir and lands, adjacent thereto in the States of Wyoming and Montana by the people of the United States and for preservation of the scenic, scientific, and historic features contributing to public enjoyment of such lands and waters" (16 USC§ 460t). Bighorn Canyon can be accessed via the major east-west corridor of Interstate 90, Wyoming State Highway 14A, or State Road 313 in Montana (map 1).

More than one million personal watercraft[1] (PWC) are estimated to be in operation today in the United States. Sometimes referred to as "jet skis" or "wet bikes," these vessels use an inboard, internal combustion engine powering a water jet pump as its primary source of propulsion. They are used for enjoyment, particularly for touring and maneuvers such as wave jumping, and they are capable of speeds in the range of 60 mph. The Personal Watercraft Industry Association (PWIA) believes that through the year 2002, most PWC output is between 155 and 165 horsepower (PWIA 2002b).

The National Park Service (NPS) maintains that PWC use emerged and gained popularity in park units before it could initiate and complete a "full evaluation of the possible impacts and ramifications." While PWC use remains a relatively new recreational activity, it has occurred in 32 of 87 park units that allow motorized boating.

The National Park Service first began to study personal watercraft in Everglades National Park. The studies showed that PWC use over emergent vegetation, shallow grass flats, and mud flats commonly used by feeding shore birds damaged the vegetation, adversely impacted the shore birds, and disturbed the life cycles of other wildlife. Consequently, managers at Everglades determined that PWC use remained inconsistent with the resources, values, and purposes for which the park was established. In 1994, the National Park Service prohibited personal watercraft by a special regulation at the park (59 FR [*Federal Register*] 58781).

Other public entities have taken steps to limit, and even to ban, PWC use in certain waterways as national researchers study more about the effects of PWC use. At least 34 states have either implemented or have considered regulating the use and operation of personal watercraft (63 FR at 49314). Similarly, various federal agencies, including the U.S. Fish and Wildlife Service and the National Oceanic and Atmospheric Administration, have managed personal watercraft differently than other classes of motorized watercraft.

Specifically, the National Oceanic and Atmospheric Administration regulates the use of personal watercraft in most national marine sanctuaries. The regulation resulted in a court case where the Court of Appeals for the District of Columbia declared such PWC-specific management valid. In *Personal Watercraft Industry Association v. Department of Commerce*, 48 F.3d 540 (D. C. Cir. 1995), the court ruled that an agency can discriminate and manage one type of vessel (specifically personal watercraft) differently than other vessels if the agency explains its reasons for the differentiation.

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1. Personal watercraft, as defined in 36 CFR §1.4(a) (2000), refers to a vessel, usually less than 16 feet in length, which uses an inboard, internal combustion engine powering a water jet pump as its primary source of propulsion. The vessel is intended to be operated by a person or persons sitting, standing, or kneeling on the vessel, rather than within the confines of the hull. The length is measured from end to end over the deck excluding sheer, meaning a straight line measurement of the overall length from the foremost part of the vessel to the aft most part of the vessel, measured parallel to the centerline. Bow sprits, bumpkins, rudders, outboard motor brackets, and similar fittings or attachments, are not included in the measurement. Length is stated in feet and inches.

In February 1997, the Tahoe Regional Planning Agency (TRPA), the governing body charged with ensuring no derogation of Lake Tahoe's water quality, voted unanimously to ban all two-stroke, internal combustion engines including personal watercraft because of their effects on water quality. Lake Tahoe's ban began in 2000.

In July 1998, the Washington State Supreme Court in *Weden V. San Juan County* (135 Wash. 2d 678 [1998]) found that the county had the authority to ban the use of personal watercraft as a proper use of its police power in order to protect the public health, safety, or general welfare. Further, personal watercraft are different from other vessels, and Washington counties have the authority to treat them differently.

In recognition of its duties under the *Organic Act* and NPS *Management Policies* (NPS 2000c), as well as increased awareness and public controversy, the National Park Service reevaluated its methods of PWC regulation. Historically, the National Park Service grouped personal watercraft with all vessels; thus, people could use personal watercraft when the unit's superintendent's compendium allowed the use of other vessels. Later the National Park Service closed seven units to PWC use through the implementation of horsepower restrictions, general management plan revisions, and park-specific regulations such as those promulgated by Everglades National Park.

In May 1998, the Bluewater Network, a coalition of more than 70 organizations representing more than 4 million Americans, filed a petition urging the National Park Service to initiate a rulemaking process to prohibit PWC use throughout the national park system. In response to the petition, the National Park Service issued an interim management policy requiring superintendents of parks where personal watercraft can occur but where it had never occurred to close the unit to such use until the rule was finalized. In addition, the National Park Service proposed a specific PWC regulation premised on the notion that personal watercraft differ from conventional watercraft in terms of design, use, safety record, controversy, visitor impacts, resource impacts, horsepower-to-vessel-length ratio, and thrust capacity (63 FR 49, 312–17, Sept. 15, 1998).

The National Park Service envisioned the servicewide regulation as an opportunity to evaluate impacts from PWC use before authorizing the use. The preamble to the servicewide regulation calls the regulation a "conservative approach to managing PWC use" considering the resources concerns, visitor conflicts, visitor enjoyment, and visitor safety. During a 60-day comment period the National Park Service received nearly 20,000 comments on the proposed regulation.

As a result of public comments and further review, the National Park Service promulgated an amended regulation that prohibited PWC use in most units and required the remaining units to determine the appropriateness of continued PWC use (36 CFR 3.24(a), current draft; 65 FR 15,077–90, Mar. 21, 2000). Specifically, the regulation allowed the National Park Service to designate PWC use areas and to continue their use by promulgating a special regulation in 11 units by amending the units' superintendents' compendiums in 10 units, including Bighorn Canyon National Recreation Area (36 CFR 3.24(b), current draft). (Bighorn Canyon was one of the compendium parks, not one of the special regulation parks.) The National Park Service based the distinction between designation methods on the units' degree of motorized watercraft use.

In response to the PWC final regulation, Bluewater Network sued the National Park Service under the *Administrative Procedures Act* and the NPS *Organic Act*. The organization challenged NPS's decision to allow continued PWC use in 21 units while prohibiting such use in other units. In addition, the organization also disputed the NPS decision to allow 10 units to continue PWC use after 2002 by making entries in superintendents' compendiums, which would not require the opportunity for public input through a notice and comments rulemaking process. Further, the environmental group claimed that because personal watercraft cause water and air pollution, generate increased noise levels, and pose public

safety threats, the National Park Service acted arbitrarily and capriciously when making the challenged decisions.

In response to the suit, the National Park Service and the environmental group negotiated a settlement. The resulting settlement agreement, signed by the judge on April 12, 2001, changed portions of the NPS's PWC rule. While 21 units could continue PWC use in the short-term, each of those parks desiring to continue long-term PWC use must promulgate a park-specific special regulation in 2002. In addition, the settlement stipulates that the National Park Service must base its decision to issue a park-specific special regulation to continue PWC use through an environmental analysis conducted in accordance with the *National Environmental Policy Act* (NEPA). The NEPA analysis at a minimum, according to the settlement, must evaluate PWC impacts on water quality, air quality, soundscapes, wildlife, wildlife habitat, shoreline vegetation, visitor conflicts, and visitor safety.

In 2001, the National Park Service adopted its new management policy for personal watercraft. The policy prohibits PWC use in national park system units unless their use remains appropriate for the specific park unit (NPS *Management Policies* [NPS 2000c, sec. 8.2.3.3]). The policy statement authorizes the use based on the park's enabling legislation, resources, values, other park uses, and overall management strategies.

As the settlement deadline approached and the park units were preparing to prohibit PWC use, the National Park Service, Congress, and PWC user groups sought legal methods to keep the parks open to this activity. On March 28, 2002, the Personal Watercraft Industry Association filed suit against the National Park Service for its final PWC regulation, challenging its discrimination between personal watercraft and other vessels and the NPS decision to close units without conducting an environmental analysis. PWIA requested the court enjoin the National Park Service from implementing the ban on PWC use effective April 22, 2002. The court refused to enjoin the ban. On April 22, 2002, the following units closed for PWC use: Assateague Island National Seashore, Big Thicket National Preserve, Pictured Rocks National Lakeshore, Fire Island National Seashore, and Gateway National Recreation Area. On September 15, 2002, eight other park units were scheduled to close to PWC use including Bighorn Canyon National Recreation Area.

The September 15, 2002 prohibition of personal watercraft was averted with the execution of a stipulated modification to the settlement agreement. The modified settlement agreement was approved by the court on September 9, 2002, and extended unrestricted personal watercraft use in some selected national park system units until November 6, 2002.

Bighorn Canyon National Recreation Area was closed to PWC use after November 6, 2002, and is to remain closed until the environmental assessment process has been completed. If an alternative is selected to continue PWC use, then a special regulation to authorize that use in the future will be drafted.

PURPOSE OF AND NEED FOR ACTION

The purpose of and the need for taking action is to evaluate a range of alternatives and strategies for the management of PWC use at Bighorn Canyon National Recreation Area in order to ensure the protection of park resources and values, while offering recreational opportunities as provided for in the national recreation area's enabling legislation, purpose, mission, and goals. Upon completion of the *National Environmental Policy Act* (NEPA) process, the National Park Service may either take action to adopt special regulations to manage PWC use at Bighorn Canyon, or remain closed to PWC use as allowed for in the National Park Service March 2000 rule.

This environmental assessment evaluates three alternatives concerning the use of personal watercraft at Bighorn Canyon. The alternatives include:

- *Alternative A* – Reinstate PWC use under a special regulation as previously managed in accordance with NPS *Management Policies* (NPS 2000c), park practices, and state regulations.

- *Alternative B* – Reinstate PWC use under a special regulation with additional management prescriptions, such as limiting areas of use.

- *No-Action Alternative* – PWC use would not be reinstated. No special rule would be promulgated.

SCOPE OF THE ANALYSIS

Motorboats and other watercraft have been used in Bighorn Canyon since 1968. Personal watercraft have been observed at Bighorn Canyon only since the 1990s. While some effects of PWC use are similar to other watercraft and, therefore, difficult to distinguish, the focus of this action is in support of decisions and rulemaking specific to PWC use. However, while the settlement agreement and need for action have defined the scope of this environmental assessment, NEPA requires an analysis of cumulative effects on resources of all past, present, and reasonably foreseeable actions when added to the effects of the proposal (40 CFR 1508.7, 2000). The scope of this analysis, therefore, is to define management alternatives specific to PWC use, in consideration of other uses, actions, and activities cumulatively affecting park resources and values.

PURPOSE AND SIGNIFICANCE OF BIGHORN CANYON NATIONAL RECREATION AREA

Congress establishes national park system units to fulfill specified purposes, based on a park's unique and significant resources. The laws creating Bighorn Canyon National Recreation Area serve as the basic building block for its decisions pertaining to preservation of scenic, scientific, and historic features and contributing to public enjoyment of lands and waters.

LEGISLATIVE INTENT OF BIGHORN CANYON NATIONAL RECREATION AREA

The laws creating Bighorn Canyon provide for the National Park Service to:

"provide for public outdoor recreation and use and enjoyment of the Yellowtail Reservoir and lands adjacent thereto in the states of Wyoming and Montana by the people of the United States and for preservation of the scenic, scientific, and historic features contributing to public enjoyment of such lands and waters" (16 USC§ 460t).

PURPOSE OF BIGHORN CANYON NATIONAL RECREATION AREA

The purpose and significance statements listed below are from Bighorn Canyon's *Strategic Plan* (NPS 2001c) and *Master Plan* (NPS 1971). Bighorn Canyon National Recreation Area was established to:

- Provide for public outdoor recreation use and enjoyment of the Yellowtail Reservoir and lands adjacent thereto within the exterior boundary of the National Recreation Area on NPS lands.

- Preserve the scenic, scientific and historic features contributing to public enjoyment of such lands and waters.

- To coordinate administration of the recreation area with the other purposes of the Yellowtail Reservoir project so that it will best provide for (1) public outdoor recreation benefits; (2) preservation of scenic, scientific, and historic features contributing to public enjoyment; and (3) management, utilization and disposal of renewable natural resources that promotes or is compatible with and does not significantly impair public recreation or scenic, scientific, or historic, or features contributing to public enjoyment.

SIGNIFICANCE OF BIGHORN CANYON NATIONAL RECREATION AREA

Bighorn Canyon National Recreation Area is significant for the following reasons.

- The outstanding scenic and recreational values of the 70-mile long, 12,700 acre Bighorn Lake.

- The history of over 10,000 years of continuous human habitation.

- The contribution the recreation area is making to the preservation of wild horses on the Pryor Mountain Wild Horse Range, of which one-third is located within the recreation area, as well as the preservation of a Bighorn sheep herd that repatriated the area in the early 1970s.

- The 19,000 acre Yellowtail Wildlife Habitat, which preserves one of the best examples of a Cottonwood Riparian area remaining in the western United States.

MISSION STATEMENT OF BIGHORN CANYON NATIONAL RECREATION AREA

Bighorn Canyon National Recreation Area is dedicated to providing the necessary recreational opportunities and facilities to allow for the public use and enjoyment of Yellowtail Reservoir and adjacent lands managed by the National Park Service. The area is also dedicated to the preservation of the scenic, scientific and historic features contributing to public enjoyment of such lands and waters. At the same time, the national recreation area also provides for coordination of the administration of the area with the other purposes of the Yellowtail project.

BACKGROUND

NPS ORGANIC ACT AND MANAGEMENT POLICIES

By enacting the NPS *Organic Act of 1916*, Congress directed the National Park Service to manage units under its jurisdiction "to conserve the scenery and the natural and historic objects and the wildlife therein and to provide for the enjoyment of the same in such manner and by such means as will leave them unimpaired for the enjoyment of future generations" (16 USC 1). Congress reiterated this mandate in the *Redwood National Park Expansion Act of 1978* by stating that the National Park Service must conduct its actions in a manner that will ensure no "derogation of the values and purposes for which these various areas have been established, except as may have been or shall be directly and specifically provided by Congress" (16 USC 1 a-1).

Despite these mandates, the *Organic Act* and its amendments afford the National Park Service latitude when making resource decisions that balance visitor recreation and resource preservation. By these acts Congress "empowered the National Park Service with the authority to determine what uses of park resources are proper and what proportion of the parks resources are available for each use" (*Bicycle Trails Council of Marin v. Babbitt,* 82 F.3d 1445, 1453 (9th Cir. 1996)).

Yet, courts consistently interpreted the *Organic Act* and its amendments to elevate resource conservation above visitor recreation. *Michigan United Conservation Clubs v. Lujan,* 949 F.2d 202, 206 (6th Cir. 1991) states, "Congress placed specific emphasis on conservation." The *National Rifle Ass'n of America v. Potter,* 628 F.Supp. 903, 909 (D.D.C. 1986) states, "In the *Organic Act* Congress speaks of but a single purpose, namely, conservation." The NPS *Management Policies* also recognize that resource conservation takes precedence over visitor recreation. The policy dictates "when there is a conflict between conserving resources and values and providing for enjoyment of them, conservation is to be predominant" (NPS *Management Policies* [NPS 2000c, sec.1.4.3]).

Because conservation remains predominant, the National Park Service seeks to avoid or to minimize adverse impacts on park resources and values. Yet, the Park Service has discretion to allow negative impacts when necessary (NPS *Management Policies* [NPS 2000c, sec. 1.4.3]). While some actions and activities cause impacts, the National Park Service cannot allow an adverse impact that constitutes a resource impairment (NPS *Management Policies* [NPS 2000c, sec.1.4.3]). The *Organic Act* prohibits actions that permanently impair park resources unless a law directly and specifically allows for the acts (16 USC 1 a-1). An action constitutes an impairment when its impacts "harm the integrity of park resources or values, including the opportunities that otherwise would be present for the enjoyment of those resources or values" (NPS *Management Policies* [NPS 2000c, sec.1.4.4]). To determine impairment, the National Park Service must evaluate "the particular resources and values that would be affected; the severity, duration, and timing of the impact; the direct and indirect effects of the impact; and the cumulative effects of the impact in question and other impacts" (NPS *Management Policies* [NPS 2000c, sec.1.4.4]).

Because park units vary based on their enabling legislation, natural resources, cultural resources, and missions, the recreational activities appropriate for each unit and for areas within each unit vary as well. An action appropriate in one unit could impair resources in another unit. Thus, this environmental assessment analyzes the context, duration, and intensity of impacts related to PWC use at Bighorn, as well as potential for resource impairment, as required by *Director's Order # 12: Conservation Planning, Environmental Impact Analysis and Decision-making* (DO #12 [NPS 2001a]).

SUMMARY OF NATIONAL RESEARCH ON THE EFFECTS OF PERSONAL WATERCRAFT

Over the past two decades personal watercraft use in the United States increased dramatically. However, there are conflicting data about whether PWC use is continuing to increase. While the National Transportation Safety Board (NTSB) estimates that retailers sell approximately 200,000 personal watercraft each year and people currently use another 1 million (NTSB 1998); the PWC industry argues that PWC sales have decreased by 50% from 1995 to 2000 (American Watercraft Association [AWA] 2001). National PWC ownership increased every year between 1991 and 1998; the rate of annual increase peaked in 1994 at 32% and dropped slightly in 1999, 2000, and 2001 (see table 1).

The majority of personal watercraft used today are powered by conventional two-stroke engines (NPS 1998, California Air Resources Board [CARB] 1999). A typical conventional (i.e., carbureted) two-stroke PWC engine discharges as much as 30% of its fuel unburned directly into the water (NPS 1999; CARB 1999). At common fuel consumption rates, an average two-hour ride on a personal watercraft may

TABLE 1: NATIONAL PWC REGISTRATION TREND

Year	Number of Boats Owned	Number of Personal Watercraft Owned	Boat Ownership Trend (Percent Change)	PWC Ownership Trend (Percent Change)
1991	16,262,000	305,915	—	—
1992	16,262,000	372,283	0%	21.7%
1993	16,212,000	454,545	0%	22.1%
1994	16,239,000	600,000	0%	32.0%
1995	15,375,000	760,000	-5%	26.7%
1996	15,830,000	900,000	3%	18.4%
1997	16,230,000	1,000,000	3%	11.1%
1998	16,657,000	1,100,000	3%	10.0%
1999	16,773,000	1,096,000	1%	-0.4%
2000	16,965,000	1,078,400	1%	-1.6%
2001		1,053,560		-2.4%

Source of boat information: USCG 2001.

Source of PWC information: National Marine Manufacturers Association (NMMA) 2002.

discharge 3 gallons of fuel into the water (NPS 1999). According to data from the California Air Resources Board, two-stroke PWC engines may consume 5 to 10 gallons of fuel per hour, of which up to 3.3 gallons per hour may be discharged unburned (CARB 1998b).

PWIA notes that direct-injection engines have been available in personal watercraft for four years; and three PWC manufacturers introduced four-stroke engines for the 2002 model year (PWIA 2002a). The U.S. Environmental Protection Agency (EPA) assumes that the existing two-stroke engine models would not be completely replaced by newer PWC technology until 2050 (40 CFR 89, 90, 91).

The average operating life of a personal watercraft is 5 to 10 years, depending upon the source. The formula for determining the operating life of personal watercraft was published in the Federal Register on October 4, 1996 (EPA 1996a). Based on this formula, the National Park Service expects that by 2012, most boat owners will already be in compliance with the 2006 EPA marine engine standards. The Personal Watercraft Industry Association believes the typical operating life of a personal watercraft rental is three years and approximately five to seven years for a privately owned vessel (PWIA 2002a).

Environmental groups, PWC users and manufacturers, and land managers express differing opinions about the environmental consequences of PWC use, and about the need to manage or to limit this recreational activity. Research conducted by various agencies and others on the effects of PWC use is summarized below for water pollution, air pollution, noise, wildlife impacts, shoreline vegetation and erosion effects, and health and safety concerns.

Water Pollution

A typical conventional (i.e., carbureted) two-stroke PWC engine discharges as much as 30% of its fuel unburned directly into the water (NPS 1999; CARB 1999). At common fuel consumption rates, an average two-hour ride on a personal watercraft may discharge 3 gallons of fuel into the water (NPS 1999). According to data from the California Air Resources Board, two-stroke PWC engines may consume 5 to 10 gallons of fuel per hour, of which up to 3.3 gallons per hour may be discharged unburned (CARB 1998b).

Hydrocarbons, benzene, toluene, ethyl benzene, and xylene (BTEX) are also released, as well as methyl tertiary-butyl ether (MTBE) in states that use this additive. In 1996, the Environmental Protection Agency promulgated a rule to control exhaust emissions from new marine engines, including outboards and personal watercraft. Emission controls provide for increasingly stricter standards beginning in model year 1996 (EPA 1997). The amount of pollution directly attributed to personal watercraft compared to other motorboats, and the degree to which personal watercraft affect water quality remains debatable. As noted in a report by the Oregon Department of Environmental Quality, every water body has different conditions (e.g., water temperature, air temperature, water mixing, motorboat use, and winds) that affect the pollutants' impacts (ODEQ 1999).

A recent study conducted by the California Air Resources Board consisted of a laboratory test designed to comparatively evaluate exhaust emissions from marine and PWC engines, in particular two- and four-stroke engines (CARB 2001). The results of this study showed a difference in emission (in some cases 10 times higher total hydrocarbons in two-stroke engines) between these two types of engines. An exception was air emissions of nitrogen oxides (NO_x) which was higher in four-stroke than in two-stroke engines. Concentrations of pollutants (MTBE and BTEX) in the tested water were consistently higher for two-stroke engines.

In 1996, the Environmental Protection Agency estimated an overall 52% reduction in hydrocarbon emissions from marine engines from present levels by 2010, and a 75% reduction by 2030, based on conversion of polluting machines. The 1997 EPA rule delayed implementation by one year (EPA 1996a, 1997). A recent study by the Tahoe Regional Planning Agency (2003) compared the concentrations of PAH compounds released into the water and found that the two-stroke carbureted outboard engine emitted lower PAH levels into the water than did the two-stroke direct-injected engine. The four-stroke carbureted outboard engine emitted the lowest PAH levels, as well as other gasoline-related contaminants into the water (TRPA 2003; CARB 2001). However, the two-stroke carbureted outboard engine emitted higher levels of benzene than the two-stroke direct-injected engine model (CARB 2001). PWC engines follow the same patterns of emission rates as outboard engines (CARB 2001). The TRPA (2003) study confirms other findings regarding emissions into the water and does not substantially change NPS conclusions regarding water quality impacts (see "Environmental Consequences" chapter, "Water Quality" section).

Low-emissions engines, including both four-stroke engines and direct-injection two-stroke engines, generate reduced amounts of most air pollutants, including carbon monoxide, particulate matter, hydrocarbons, and volatile organic compounds. However, the low-emission engines produce more nitrogen oxides than do carbureted two-stroke engines (EPA 1996a) and the two-stroke direct injected engine has been shown to generate more airborne-particulate PAH emissions, a class of volatile organic compounds, than the two-stroke carbureted engines (Kado et al. 2000). The Environmental Protection Agency estimates that conversion to four-stroke engines and two-stroke direct injection will both result in an increase in the level of nitrogen oxides produced by personal watercraft engines. In order to meet stringent hydrocarbon emission reduction contained in the EPA final rule, the Environmental Protection Agency estimates that manufacturers will need to recalibrate their engines to run at leaner air-fuel ratios, resulting in higher combustion temperatures, more complete combustion, and some increase in nitrogen oxide formation. In addition, conversion to two-stroke direct inject and four-stroke technology have little internal exhaust gas recirculation (EGR) which could reduce emission rates of nitrogen oxides (EPA 1996a).

Discharges of MTBE and PAH particularly concern scientists because of their potential to adversely affect the health of people and aquatic organisms. Scientists need to conduct additional studies on PAH (Allen et al. 1998) and on MTBE (NPS 1999), as well as long-term studies on the effect of repeated exposure to low levels of these pollutants (Asplund 2001).

At Lake Tahoe concern about the negative impact on lake water quality and aquatic life caused by the use of two-stroke marine engines led to at least 10 different studies relevant to motorized watercraft in the Tahoe Basin in 1997 and 1998. The results of these studies (Allen et al. 1998) confirm that (1) petroleum products are in the lakes as a result of motorized watercraft operation, and (2) watercraft powered by carbureted two-stroke engines discharge pollutants at an order of magnitude greater than do watercraft powered by newer technology engines (TRPA 1999).

On June 25, 1997, the Tahoe Regional Planning Agency adopted an ordinance prohibiting the "discharge of unburned fuel and oil from the operation of watercraft propelled by carbureted two-stroke engines" beginning June 1, 1999. Following the release of an environmental assessment in January 1999, this prohibition was made permanent.

PAH, as well as other hydrocarbon emissions, could potentially be reduced as new four-stroke and direct-injection engines replace older carbureted two-stroke engines. The conversion of carbureted two-stroke engines would be an important step toward substantially reducing petroleum related pollutants.

Some research shows that PAH, including those from personal watercraft emissions, adversely affect water quality via harmful phototoxic effects on ecologically sensitive plankton and other small water organisms (EPA 1998; Oris et al. 1998; Landrum et al. 1987; Mekenyan et al. 1994; Arfsten et al. 1996). This in turn can affect aquatic life and ultimately aquatic food chains. The primary concern is in shallow water ecosystems.

Air Pollution

A typical conventional (i.e., carbureted) two-stroke PWC engine discharges as much as 30% of its fuel unburned directly into the water (NPS 1999; CARB 1999). At common fuel consumption rates, an average two-hour ride on a personal watercraft may discharge 3 gallons of fuel into the water (NPS 1999). According to data from the California Air Resources Board, two-stroke PWC engines may consume 5 to 10 gallons of fuel per hour, of which up to 3.3 gallons per hour may be discharged unburned (CARB 1998b). The combustion process results in emissions of air pollutants such as volatile organic compounds (VOC), NO_x, particulate matter (PM), and carbon monoxide (CO). In areas with high PWC use, some air quality degradation likely occurs (EPA 1996a).

PAH are released during the combustion of fuel, though some PAH are also found in unburned gasoline. Kado et al. 2000 indicated that changing from two-stroke carbureted engines to two-stroke direct-injection engines may result in increases of airborne particulate-associated PAH. The same study indicated that four-stroke engines have considerably less PAH emissions than two-stroke engines.[2] A subsequent study of airborne emissions indicated a potential health risk from toxic pollutants in areas of high concentration of exhaust from many engines, such as in an engine maintenance shop (Kado, Kuzmicky, and Okamoto 2001).

At Bighorn Canyon, personal watercraft do not congregate in areas where exhaust would be concentrated. As engines are converted from two-stroke to four-stroke types, the emissions of PAH are expected to decrease.

2. It is noted that only one engine of each type (two-stroke carbureted, two-stroke direct injection, and four-stroke) was tested.

In August 2002, the Environmental Protection Agency proposed additional rules that would further reduce boating emissions. The proposal includes evaporative emission standards for all boats and would reduce emissions from fuel tanks by 80% (67 FR 157, August 14, 2002, pp. 53049-53115).

Noise

Personal watercraft-generated noise varies from vessel to vessel. No literature was found that definitively described scientific measurements of personal watercraft noise. Some literature stated that all recently manufactured watercraft emit fewer than 80 decibels (dB) at 50 feet from the vessel, while other sources attributed levels as high as 102 decibels without specifying the distance. None of this literature fully described the method used to collect noise data.

The National Park service contracted for noise measurements of personal watercraft and other motorized vessels in 2001 at Glen Canyon National Recreation Area (Harris et al. 2002). The results show that maximum personal watercraft noise levels at 25 meters (82 feet) ranged between 68 to 76 decibels on the A-weighted scale (dBA). Noise levels for other motorboat types measured during that study ranged from 65 to 86 decibels at 25 meters (82 feet).

Noise limits established by the National Park Service require vessels to operate at less than 82 dB at 82 feet from the vessel. Personal watercraft may be more disturbing than other motorized vessels because of rapid changes in acceleration and direction of noise. However, this regulation does not imply that there are no noise impacts from vessels operating below that limit. Noise impacts from PWC use are caused by a number of factors. Noise from human sources, including personal watercraft, can intrude on natural soundscapes, masking the natural sounds, which are an intrinsic part of the environment. This can be especially true in quiet places, such as in secluded lakes, coves, river corridors, and backwater areas. Also, PWC use in areas where there are non-motorized users (such as canoeists, sailing enthusiasts, people fishing or picnicking, and kayakers) can disrupt the “passive” experience of park resources and values.

Komanoff and Shaw (2000) note that the biggest difference between noise from personal watercraft and that from motorboats is that the former continually leave the water, which magnifies noise in two ways. Without the muffling effect of water, the engine noise is typically 15 dBA louder and the smacking of the craft against the water surface results in a loud “whoop” or series of them. With the rapid maneuvering and frequent speed changes, the impeller has no constant “throughput” and no consistent load on the engine. Consequently, the engine speed rises and falls, resulting in a variable pitch. This constantly changing sound is often perceived as more disturbing than the constant sound from motorboats.

PWC users tend to operate close to shore, to operate in confined areas, and travel in groups, making noise more noticeable to other recreationists (e.g., if identical boats emit 75 dB, two such boats together would be expected to emit 76 dB, 3 together would emit 77 dB). Motorboats traveling back and forth in one area at open throttle or spinning around in small inlets also generate complaints about noise levels; however, most motorboats tend to operate away from shore and navigate in a straight line, thus being less noticeable to other recreationists (Vlasich 1998).

Research conducted by the Izaak Walton League (IWL) indicates that one PWC unit can emit between 85 and 105 dB of sound, and that wildlife or humans located 100 feet away may hear sounds of 75 dB. This study also stated that rapid changes in acceleration and direction may create a greater disturbance and emit sounds of up to 90 dB (IWL 1999). Other studies conducted by the New Jersey State Police indicate that a PWC unit with a 100-horsepower (hp) engine emits up to 76 dBA, while a single, 175-hp outboard engine emits up to 81 dBA.

Sea-Doo research indicates that in three out of five distances measured during a sound level test, PWC engines were quieter than an outboard motorboat. Sea-Doo also found that it would take approximately four PWC units, 50 feet from the shore to produce 77 dBA, and it would take 16 PWC vessels operating at 15 feet from the shore to emit 83 dBA of sound, which is equal to one open exhaust boat at 1,600 feet from the shore. With new designs of personal watercraft, engines may be quieter. In response to public complaints, the PWC industry has employed new technologies to reduce sound by about 50% to 70% on 1999 and newer models (Sea-Doo 2000; Hayes 2002). Additionally, by 2006 the EPA requirements will reduce PWC noise, in association with improvements to engine technology (EPA 1996b). EPA research also indicated that one PWC unit operating 50 feet from an onshore observer emits a sound level of 71 dBA, and studies conducted using the Society of Automotive Engineers (2001) found that two PWC units operating 50 feet from the shore emit similar sound levels of about 74 dBA (PWIA 2000).

Most studies on the effects of noise on soundscapes and human receptors have focused on highway and airport noise. Komanoff and Shaw (2000) used the analytical approaches of these studies to perform a noise-cost analysis of personal watercraft. They concluded that the cost to beachgoers from personal watercraft noise was more than $900 million per year. The cost per personal watercraft was estimated to be about $700 per vessel each year or $47 for each 3-hour "personal watercraft day." They concluded that the cost per beachgoer was the highest at secluded lake sites, where beachgoers had a higher expectation of experiencing natural quiet and usually invested a larger amount of time and personal energy in reaching the area. However, because there are many more visitors to be affected at popular beaches, noise costs per personal watercraft were highest at crowded sites (*Drowning in Noise: Noise Costs of Jet Skis in America* [Komanoff and Shaw 2000]).

Wildlife Impacts

Few studies have specifically examined PWC effects on wildlife. Based on observations, some wildlife disturbances and harassment likely occurs, probably caused by speed, noise, and access. Nesting colonial birds are particularly susceptible to disturbance; however, the extent, duration, and magnitude of biological impacts because of PWC operations versus other motorboats remain unknown. Burger (2000) examined the related to common terns in relation to PWC use and other boats and noted that PWC users traveled faster and came closer to banks, resulting in more flight response in terns and contributing to lower reproductive success.

Shoreline Vegetation

The effects of personal watercraft on aquatic communities have not been fully studied, and scientists disagree about whether personal watercraft adversely impact aquatic vegetation. The majority of concern arises from the shallow draft of personal watercraft, allowing access to shallow areas that conventional motorboats cannot reach. Like other vessels, personal watercraft may destroy grasses that occur in shallow water ecosystems. Anderson (2000) studied the effect of PWC wave-wash on shallow salt marsh vegetation and found that although the waves from personal watercraft are not different from those generated by other boats, personal watercraft can enter marsh channels and create sediment suspension problems in these areas.

Erosion Effects

Some studies have examined the erosion effects of personal watercraft waves and other studies suggest that personal watercraft may disturb sediments on river or lake bottoms and cause turbidity. Conflicting research exists concerning whether PWC-caused waves result in erosion and sedimentation. PWC-

generated wave sizes vary depending on the environment, including weight of the driver, number of passengers, and speed. Anderson (2000) studied the effect of PWC wave-wash on shallow salt marsh vegetation and found that, although the waves from personal watercraft are not different from those generated by other boats, personal watercraft can enter marsh channels and create sediment suspension problems in these areas.

Health and Safety Concerns

Increased PWC use in recent years has resulted in more concern about the health and safety of operators, swimmers, snorkelers, divers, and other boaters. A 1998 NTSB study revealed that while recreational boating fatalities have been declining in recent years, PWC-related fatalities have increased (NTSB 1998). Nationwide PWC accident statistics provided by the U.S. Coast Guard (USCG) supports the increase in PWC-related fatalities (see table 2) however, since a peak of 84 PWC-related fatalities in 1997, accidents, injuries, and fatalities involving personal watercraft have decreased. The U.S. Coast Guard's Office of Boating Safety studied exposure data to assess boating risks. This method allows for a comparison between boat types based on comparable time in the water. Personal watercraft use ranked second in boat type for fatalities per million hours of exposure in 1998, with a 0.24 death rate per million exposure hours.

Since PWC operators can be as young as 12 in several states, accidents can involve children. The American Academy of Pediatrics (2000) recommends that no one younger than 16 operate personal watercraft. Some manufacturing changes on throttle and steering may reduce potential accidents. For example, on more recent models, Sea-Doo developed an off-power assisted steering system that helps steer during off-power as well as off-throttle situations. This system, according to company literature, is designed to provide additional maneuverability and improve the rate of deceleration (Sea-Doo 2001a).

TABLE 2: NATIONWIDE PWC ESTIMATES AND ACCIDENT STATISTICS

Year	Recreational Boats Owned*	PWC Owned*	Number of PWC in Accidents	Number of PWC Injuries	Number of PWC Fatalities	Number of All Boats Involved in Accidents	Percent of PWC Involved in Accidents
1987	14,515,000	N/A	376	156	5	9,020	4.2%
1988	15,093,000	N/A	650	254	20	8,981	7.2%
1989	15,658,000	N/A	844	402	20	8,020	10.5%
1990	15,987,000	N/A	1,162	532	28	8,591	13.5%
1991	16,262,000	305,915	1,513	708	26	8,821	17.2%
1992	16,262,000	372,283	1,650	730	34	8,206	20.1%
1993	16,212,000	454,545	2,236	915	35	8,689	25.7%
1994	16,239,000	600,000	3,002	1,338	56	9,722	30.9%
1995	15,375,000	760,000	3,986	1,617	68	11,534	34.6%
1996	15,830,000	900,000	4,099	1,837	57	11,306	36.3%
1997	16,230,000	1,000,000	4,070	1,812	84	11,399	35.7%
1998	16,657,000	1,100,000	3,607	1,743	78	11,368	31.7%
1999	16,773,000	1,096,000	3,374	1,614	66	11,190	30.2%
2000	16,965,000	1,078,400	3,282	1,580	68	11,079	29.6%
Total			**33,851**	**15,238**	**645**		

Source: USCG 2001.

N/A = not available.

*Estimates provided by the National Marine Manufacturers Association (USCG 2001).

PWC Use and Regulation at Bighorn Canyon National Recreation Area

Personal watercraft use on Bighorn Lake began during the early 1990s. During 2001, personal watercraft comprised approximately 4% of the boat use on Bighorn Lake. Personal watercraft were allowed to operate throughout the national recreation area, but most personal watercraft use occurs at the north end of the lake in the vicinity of Ok-A-Beh Marina. The primary use season is mid-May through mid-September. During the other months the water is generally too cold for PWC use.

Bighorn Canyon has two marinas: Horseshoe Bend and Ok-A-Beh. Both provide gas, rental docks, food, and boater supplies, typically from Memorial Day through Labor Day. Personal watercraft and other watercraft can also enter the lake at Barry's Landing, which has a launching ramp but no marina. Primitive access to the lake is available at the causeway, and access to the Bighorn and Shoshone Rivers is available throughout the Yellowtail Wildlife Habitat. Above the dam, watercraft may be launched at the Afterbay launch ramp, and on the river at the Afterbay and Three-Mile access areas.

Personal watercraft and other watercraft are piloted over the main surface of the lake, along the lakeshore, and in coves and back bays. Boaters may camp at one of the national recreation area's 156 developed campsites or at one of nearly 30 primitive campsites.

No surveys have been conducted regarding the operating hours of personal watercraft at Bighorn Canyon National Recreation Area, though most personal watercraft probably operate between the hours of dawn to dusk. There are currently no state regulations regarding hours of operation in either Montana or Wyoming. Due to the narrowness of Bighorn Lake, most watercraft activity, including use of personal watercraft, occurs in the several wide sections of the lake, or watercraft traverse back and forth across the lake. Some thrill-seeking activity by personal watercraft users does occur.

PWC use is such a small percentage of the overall boating use within Bighorn Canyon that accidents involving PWC operators vary greatly from year to year. Two accidents were recorded in 2000 and none in either 2001 or 2002.

Complaints regarding misuse of personal watercraft have been received infrequently, and the most commonly reported are wakes in the flat-wake zones near boat launch areas. Bighorn Canyon National Recreation Area has issued citations under Montana and Wyoming state law to personal watercraft users for acts such as wake jumping, under-age riding, and failing to wear floatation devises. The most common citation has been for under-age riding. Montana state law requires riders age 13 and 14 to have a certificate, and riders 12 and younger must be accompanied by an adult. Wyoming state law requires riders to be 16 years old.

Two accidents were recorded at Bighorn Canyon National Recreation Area during the 2000 and 2001 seasons. Both accidents were due to the operators' inexperience in operating personal watercraft, allowing it to run into other vessels. Statistics for other vessel accidents per year are similar.

Within 200 miles of Bighorn Canyon National Recreation Area there are several reservoirs that permit personal watercraft use including Fort Peck, Montana; Cooney Reservoir in Red Lodge, Montana; Tongue River Reservoir, Montana; Buffalo Bill Cody Reservoir (Cody), Wyoming; and Boysen Reservoir (Thermopolis), Wyoming. Some personal watercraft activity also occurs on Yellowstone River outside of Billings, Montana.

OBJECTIVES IN TAKING ACTION

Objectives define what must be achieved for an action to be considered a success. Alternatives selected for detailed analysis must meet all objectives and must also resolve purpose of and need for action.

Using Bighorn Canyon's enabling legislation, mandates and direction in the *Master Plan* (NPS 1971) and the *Strategic Plan* (NPS 2001c), issues, and servicewide objectives, park staff identified the following management objectives relative to PWC use:

WATER QUALITY

- Manage PWC emissions that enter the water in accordance with NPS anti-degradation policies and goals.
- Protect plankton and other aquatic organisms from PWC emissions so that the viability of dependent species is conserved.

AIR QUALITY

- Manage PWC activity so that PWC air emissions of harmful compounds do not appreciably degrade ambient air quality.

SOUNDSCAPES

- Manage noise from PWC use in affected areas so that visitors' health, safety, and experiences are not adversely affected.
- Protect birds, waterfowl, and other wildlife from the effects of PWC noise.

WILDLIFE AND WILDLIFE HABITAT

- Protect fish and wildlife including the bald eagle, species of concern, and their habitats from PWC disturbances.
- Protect fish and wildlife from the adverse effects that result from the bioaccumulation of contaminants emitted from personal watercraft.

THREATENED, ENDANGERED, AND SPECIAL CONCERN SPECIES

- Protect threatened and endangered species, and species of special concern, and their habitats from PWC disturbances.

SHORELINE VEGETATION

- Manage PWC use to protect sensitive shoreline areas (vegetation / erosion) from PWC activity and access.

VISITOR USE AND EXPERIENCE

- Minimize potential conflicts between PWC use and park visitors.
- Seek cooperation with state entities that regulate PWC use.

VISITOR CONFLICT AND VISITOR SAFETY

- Minimize or reduce the potential for PWC user accidents.
- Minimize or reduce the potential safety conflicts between PWC users and other water recreationists.

CULTURAL RESOURCES (SECTION 106)

- Manage PWC use and access to protect cultural resources including sacred sites important to Native Americans.

SOCIOECONOMICS

- Work cooperatively with concessioners and local businesses that rent or sell personal watercraft.

ENVIRONMENTAL JUSTICE

- Minimize disproportionate impacts on minority and low-income populations.

NATIONAL RECREATION AREA MANAGEMENT AND OPERATIONS

- Provide a safe and healthful park environment for park visitors.
- Seek cooperation with state entities that regulate PWC use.

ISSUES AND IMPACT TOPICS RELATED TO BIGHORN CANYON NATIONAL RECREATION AREA

Issues associated with PWC use at Bighorn Canyon were identified during scoping meetings with NPS staff and as a result of public comments. Many of these issues were identified in the settlement agreement with the Bluewater Network, which requires that at a minimum, the effects of PWC use be analyzed for

the following: water quality, air quality, soundscapes, wildlife and wildlife habitat, shoreline vegetation, visitor conflicts, and visitor safety. Potential impacts to other resources were considered as well. The following impact topics are discussed in the "Affected Environment" chapter and analyzed in the "Environmental Consequences" chapter. If no impacts are expected, based on available information, then the issue was eliminated from further discussion, as explained in the "Issues Eliminated from Further Consideration" section.

WATER QUALITY

A typical conventional (i.e., carbureted) two-stroke PWC engine discharges as much as 30% of its fuel unburned directly into the water (NPS 1999; CARB 1999). At common fuel consumption rates, an average two-hour ride on a personal watercraft may discharge 3 gallons of fuel into the water (NPS 1999). According to data from the California Air Resources Board, two-stroke PWC engines may consume 5 to 10 gallons of fuel per hour, of which up to 3.3 gallons per hour may be discharged unburned (CARB 1998b). Hydrocarbons, including benzene, toluene, ethyl benzene, and xylene; and PAH are released, as well as MTBEs. These discharges have potential adverse effects on water quality.

Some research shows that PAH, including those from personal watercraft emissions, adversely affect water quality via harmful phototoxic effects on ecologically sensitive plankton and other small water organisms (EPA 1998; Oris et al. 1998; Landrum et al. 1987; Mekenyan et al. 1994; Arfsten et al. 1996).

With the conversion to newer personal watercraft technology, PAH, as well as other hydrocarbon emissions into the water, may be reduced as new four-stroke engines replace older carbureted two-stroke engines. A recent study by the Tahoe Regional Planning Agency (2003) compared the concentrations of PAH compounds released into the water and found that the two-stroke carbureted outboard engine emitted lower PAH levels into the water than did the two-stroke direct-injected engine. The four-stroke carbureted outboard engine emitted the lowest PAH levels, as well as other gasoline-related contaminants into the water (TRPA 2003; CARB 2001). However, the two-stroke carbureted outboard engine emitted higher levels of benzene than the two-stroke direct-injected engine model (CARB 2001). PWC engines follow the same patterns of emission rates as outboard engines (CARB 2001). The TRPA (2003) study confirms other findings regarding emissions into the water and does not substantially change NPS conclusions regarding water quality impacts (refer to "Environmental Consequences" chapter, "Water Quality" section).

Bighorn Lake currently meets Section 303 of the *Clean Water Act* according to the states of Montana and Wyoming. The National Park Service currently measures water quality at designated swim areas, where water samples are checked for the presence of fecal coliform bacteria. Though overall water quality standards are being met at the lake, certain areas of the national recreation area may be more susceptible to water quality impacts related to gasoline emissions and discharges. These areas may include side canyon areas, Horseshoe Bend, and areas further south on the lake where water depths are shallowest.

Potential water pollution sources upstream on the Bighorn and Shoshone Rivers include small towns and communities, farming, flood irrigation, and cattle grazing. Cattle grazing and farming activities can also affect smaller drainages emptying into the lake.

Certain areas of Bighorn Lake may be more sensitive to the potential effects of phototoxicity, due to shallow-depths and the potential presence of more vulnerable aquatic life. Algae blooms have occurred on the lake in the past, and while they appear to be the heaviest in the southern end of the national recreation area they have occurred throughout the lake. The southern end of the lake is the shallower, and depending on the time of year, spring runoff, and other variables, the lake dewaters from the south to north. In early

spring, Horseshoe Bend may have only a few feet of water but by late summer may be covered by 25 to 30 feet of water. Bighorn Canyon is located at a high altitude, has clear water and receives an abundance of solar input. These environmental factors, in combination with pollutants such as PAH, can affect aquatic life and, ultimately, aquatic food chains. The primary concern is in shallow water ecosystems.

AIR QUALITY

Pollutant emissions, particularly NO_x and HC from personal watercraft, may adversely affect air quality. These compounds react with sunlight to form ozone. To the extent that nitrogen loading in the air contributes to the nutrient loading in the water column, PWC use adversely affects water quality.

Low-emissions engines, including both four-stroke engines and direct-injection two-stroke engines, generate reduced amounts of most air pollutants, including carbon monoxide, particulate matter, hydrocarbons, and volatile organic compounds. However, the low-emission engines produce more nitrogen oxides than do carbureted two-stroke engines (EPA 1996a) and the two-stroke direct injected engine has been shown to generate more airborne-particulate PAH emissions, a class of volatile organic compounds, than the two-stroke carbureted engines (Kado et al. 2000). The Environmental Protection Agency estimates that conversion to four-stroke engines and two-stroke direct injection will both result in an increase in the level of nitrogen oxides produced by personal watercraft engines. In order to meet stringent hydrocarbon emission reduction contained in the EPA final rule, the Environmental Protection Agency estimates that manufacturers will need to recalibrate their engines to run at leaner air-fuel ratios, resulting in higher combustion temperatures, more complete combustion, and some increase in nitrogen oxide formation. In addition, conversion to two-stroke direct inject and four-stroke technology have little internal exhaust gas recirculation (EGR) which could reduce emission rates of nitrogen oxides (EPA 1996a).

SOUNDSCAPES

Noise limits established by the National Park Service require vessels to operate at less than 82 dB at 82 feet from the vessel. Some research suggests that personal watercraft have a greater impact on waterfowl and nesting birds because of their noise, speed, and ability to access shallow-water areas more readily than other types of watercraft. This may force nesting birds to abandon eggs during crucial embryo development stages and flush other waterfowl from habitat, causing stress and associated behavior changes.

Due to the sheer cliffs and the amount of watercraft use, watercraft activity is quite audible on and around the lake in Bighorn Canyon National Recreation Area. Most visitors to the national recreation area use some type of boat. Two designated campgrounds on the lake are accessible only by boat. Montana has a boating regulation requiring the decibels of a vessel to be no more than 86 dB.

WILDLIFE AND WILDLIFE HABITAT

Some research suggests that PWC use impacts wildlife through interruption of normal activities, alarm or flight; avoidance and displacement of habitat; and effects on reproductive success. This is thought to be caused by a combination of PWC speed, noise and ability to access sensitive areas, especially in shallow-water depths. Literature suggests that personal watercraft can access sensitive shorelines, disrupting riparian habitat areas critical to wildlife.

In general, wildlife habitat on the shoreline of Bighorn Lake is lacking due to the steep canyon walls present throughout the majority of the national recreation area. The area south of the South Narrows below Horseshoe Bend is one area of special concern identified by the Wyoming Game and Fish Department because of the potential for nesting waterfowl when water levels are sufficient.

THREATENED AND ENDANGERED, AND SPECIAL CONCERN SPECIES

Similar to other wildlife, personal watercraft may affect federally listed or other species of concern through interruption of normal activities; alarm or flight; avoidance and displacement of habitat; and effects on reproductive success.

The only federally listed threatened or endangered species currently found within Bighorn Canyon National Recreation Area is the bald eagle. The eagles nest along the Bighorn River.

The Rocky Mountain bighorn sheep is a federal species of concern that occurs mostly on the canyon mesa tops and in more remote canyon areas. There is the potential for the noise to reverberate within the canyon and disturb sheep if PWC are operated within these areas, but the narrow reaches of the canyons are not conducive to PWC use due to a lack of shoreline for landing opportunities and habitually rough waters.

One Montana and Wyoming species of special concern is also located in areas that may be affected by shoreline activities. Persistent sepal yellowcress has been documented within the national recreation area on the mudflats at the south end of Yellowtail Reservoir (Heidel and Fertig 2002, Morstad 2003).

Other special status species are located within or have potential habitat in the national recreation area, including American peregrine falcon, mountain plover, Townsend's big-eared bat, Northern leopard frog, plains spadefoot toad, Hapeman's sullivantia, Lesica's bladderpod, and sweetwater milkvetch.

SHORELINE VEGETATION

PWC are able to access areas such as shallow waters where most other watercraft cannot go, which may result in disturbance of sensitive plant species. In addition, PWC may land on the shoreline, allowing visitors to access areas where sensitive vegetation and plant species exist.

Changes in water levels and the steep-walled canyon that constitute a majority of Bighorn Lake, result in little shoreline vegetation. In a normal year, the shoreline is under water from mid-July to mid-September, and when exposed it consists mainly of gravel. In most areas, the closest vegetation is generally 30 to 50 feet above the water on canyon ledges, with the exception of the area in Yellowtail Wildlife Habitat area south of the South Narrows.

VISITOR EXPERIENCE

Some research suggests that personal watercraft are viewed by some segments of the public as a 'nuisance' due to their noise, speed and overall environmental effects, while others believe personal watercraft are no different than other watercraft and that users have a "right" to enjoy the sport.

Some states and local governments have taken action, or are considering taking action, to limit, ban and otherwise manage PWC use. While the national recreation area may be 'exempt' from these local actions,

consistency with state and local plans must be considered. The states of Montana and Wyoming have PWC regulations that provide guidelines for PWC operation and safety at Bighorn Canyon.

The *Master Plan* (NPS 1971) discusses Bighorn Canyon National Recreation Area's mandate for public use and enjoyment. PWC management may affect the enhancement of recreational opportunities or cause changes in the methods and types of recreational activities occurring within the national recreation area (NPS 1971).

VISITOR CONFLICTS AND SAFETY

Industry representatives report that PWC accidents decreased in some states in the late 1990s. The National Transportation Safety Board reported that in 1996 personal watercraft represented 7.5% of state-registered recreational boats but accounted for 36% of recreational boating accidents. In the same year PWC operators accounted for more than 41% of people injured in boating accidents. PWC operators accounted for approximately 85% of the persons injured in accidents studied in 1997 (NTSB 1998). In part, this is believed to be a "boater education" issue (for example, inexperienced riders lose control of the craft) and also a function of the PWC operation, that is, no brakes or clutch. When drivers let up on the throttle to avoid a collision, manual steering becomes difficult.

The Personal Watercraft Industry Association (PWIA) believes that through the year 2002, most PWC output is between 155 and 165 horsepower (PWIA 2002b). Due to the ability of some PWC to reach speeds in the 60 mph range and their ability to access shallow-draft areas, personal watercraft can create wakes that pose a conflict for both shore and boat fishermen and a safety hazard to other users such as canoeists, kayakers and windsurfers. At Bighorn Canyon however, most PWC do not reach high speeds due to the lake's configuration and the lack of long stretches. There are few accesses to shallow-draft areas that can create wakes that pose a conflict and safety hazard to other users. Bighorn Canyon has very little non-motorized visitor use due to the lack of wind for sailing and the lake's characteristics (no where to land). Over a four-year span, park staff observed approximately five canoeists, kayakers and drift boaters in the Ok-A-Beh area of the lake. Of greater concern to other boaters and visitor safety are personal watercraft users approaching boats too close and jumping other boat wakes.

CULTURAL RESOURCES (SECTION 106)

Bighorn National Recreation Area has an array of cultural resources listed on or potentially eligible for listing on the National Register of Historic Places (NRHP). The majority of known archeological sites are located above the cliffs and on the Crow Indian Reservation. There are some sites on the cliff walls but they are difficult to access. Submerged sites approximately 80-feet below the water are known to exist; however, lakes levels do not fluctuate enough on a regular basis to expose such sites.

SOCIOECONOMICS

National PWC ownership increased every year between 1991 and 1998; the rate of annual increase peaked in 1994 at 32% and dropped slightly in 1999, 2000, and 2001.

Within a 100-mile radius of Bighorn Canyon National Recreation Area there are only three dealers selling personal watercraft. All three dealers are located in Billings, Montana, which is 90 miles away. None of the dealers currently rent personal watercraft. No sales or rentals of personal watercraft occur on the Crow Reservation. Users of personal watercraft have multiple lakes for use, so businesses may only be affected

by either increased or decreased personal watercraft use at Bighorn Canyon. Almost all personal watercraft in use in the national recreation area are owned by the operators. The park is not aware of any PWC rentals available in the regional area at this time.

NATIONAL RECREATION AREA MANAGEMENT AND OPERATIONS

PWC use may require additional park staff to enforce standards, limits, or closures because of increased accident rates and visitor conflicts. Managing personal watercraft under a more restrictive strategy may require additional park staff to enforce standards and limits. At the current time, law enforcement staffing is such that daily boat patrols cannot be made. Boat patrols do occur on weekends and during other periods of high visitation.

Conflict with Sate and Local Ordinances and Policies Regarding PWC Use

Some states and local governments have taken action, or are considering taking action, to limit, ban, or otherwise manage PWC use. While the national recreation area may be exempt from these local actions, consistency with state and local plans must be evaluated. Montana and Wyoming State boating laws apply to PWC users. Both Montana and Wyoming define PWC as boats or watercraft when addressing safe operations, the registering and numbering of vessels, and noise limitations.

ISSUES ELIMINATED FROM FURTHER CONSIDERATION

Economically Disadvantaged or Minority Populations (Executive Order 12898) — Residents of Big Horn Counties in Montana and Wyoming include low-income populations. However, these populations would not be particularly or disproportionately affected by continuing or discontinuing PWC use. Other areas near the national recreation area are available to all PWC users. There are no small business owners in the Bighorn Canyon area that rent personal watercraft as a primary source of income. This issue was dismissed from further analysis for the following reasons:

- Personal watercraft are used by a cross section of ethnic groups and income levels.
- Other areas are available and open to personal watercraft and are used by all ethnic groups.
- NPS actions would not disproportionately affect minority or low-income populations.
- Any NPS actions to limit PWC use would not displace PWC use to low-income or ethnically sensitive areas.

Cultural Landscapes — No new cultural resource investigations were carried out as part of this study. The findings are based on the national recreation area's existing cultural resource documentation and information provided orally by NPS employees. One cultural landscape has been identified, surveyed, or documented with Bighorn Canyon National Recreation Area to date, it is located outside the area of potential effect. It is possible that other potentially eligible landscapes could be either outside the area or potential effect or in areas already experiencing heavy visitor use.

Historic Structures — Forty-one structures are currently listed on the fiscal year (FY) 1999 National Park Service List of Classified Structures (LCS) for Bighorn Canyon. Three ranches are listed on the National Register of Historic Places including the Ewing-Snell, Caroline Lockhart, and the ML Ranch. The Fort

C.F. Smith Historic District is also listed. No known structures have been identified within the vicinity of existing or potential future landing areas, and, therefore, this topic was dismissed from further consideration.

Museum Collections — The scope of collections for Bighorn Canyon National Recreation Area includes a variety of objects and specimens collected within the national recreation area boundaries. Data from the *2000 Collections Management Report* indicates that total objects and specimens number 4,672 with a total of 3,546 archival documents (NPS n.d. *Park Museum Collections Profile*). These items are managed as provided for in *Director's Order #24: NPS Museum Collections Management* and the *NPS Museum Handbook*. The collection is maintained within the Bighorn Canyon but outside the project area.

Ethnographic/Sacred Sites — This is not an issue at Bighorn Canyon because there are no known sacred sites or Native American concerns within Bighorn Canyon within the vicinity of existing or potential future landing areas or PWC use areas.

Wetlands — The national recreation area contains riparian-wetland sites adjacent to aquatic habitats such as streams and rivers, springs, seeps, and ponds. The portion of Bighorn Canyon National Recreation Area located south of the South Narrows in the Yellowtail Wildlife Habitat area is a cottonwood-dominated riparian habitat, with seven ponds and associated wetlands ranging in size from 1 to 75 acres. These ponds are located within the extreme high-water flood pool of Bighorn Lake and are susceptible to water fluctuations due to both normal reservoir operations and seasonal drought.

There are also several springs and associated wetland communities within the national recreation area including Lockhart Springs near Lockhart Ranch and Willow Springs east of the buildings of the Mason-Lovell Ranch. Lockhart Springs is fenced from cattle trespass, but Willow Springs and others in the national recreation area have been affected by grazing and cattle trespass (Jacobs et al. 1996).

Although these wetland areas occur within the national recreation area, they are not located in areas of PWC use or in areas that are accessible to personal watercraft and would not be affected by PWC use.

Floodplains — The level of PWC use and associated PWC activities identified in each alternative would have no adverse impacts on floodplains. No development is proposed in the alternatives; thus, no flooding would result as a result of PWC use and cause impacts to human safety, health, or welfare.

Prime and Unique Agricultural Lands — No prime and unique agricultural farmland exists in the vicinity of areas that would be affected by PWC use.

Energy Requirements and Natural or Depletable Resource Requirements — PWC operation requires the use of fossil fuels. While PWC use could be limited or banned within this park unit, no alternative considered in this environmental assessment would affect the number of personal watercraft used within the region or the amount of fuel that is consumed. The level of PWC use considered in this environmental assessment is minimal. Fuel is not now in short supply, and PWC use would not have an adverse effect on continued fuel availability.

RELATIONSHIP TO OTHER PLANS, POLICIES AND ACTIONS

The current *Strategic Plan* for 2001-2005 and the *Master Plan* (NPS 1971) for Bighorn Canyon give direction for appropriate visitor activities and facilities at specific places in the national recreation area. These plans and policies are also considered in the analysis of cumulative effects. There are no substantive changes to population, land use, or park management anticipated within the next 10 years.

Map 1: Location

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ALTERNATIVES

All alternatives must be consistent with the purpose and significance of the Bighorn Canyon National Recreation Area, and must meet the purpose of and need for action, as well as the objectives for the project. Three alternatives are described in this section.

The alternatives analyzed in this document in accordance with the *National Environmental Policy Act* are the result of agency and public scoping input, and as stipulated in the settlement agreement between Bluewater Network and the National Park Service. Bighorn Canyon was closed to PWC use after November 6, 2002. The action alternatives address continued PWC use under a special regulation assuming management conditions prior to November 2002 or under new management strategies and mitigation measures. The no-action alternative would not reinstate PWC use, thus continuing the ban instituted in November 2002.

Table 3 summarizes the alternatives being considered, table 4 summarizes the impacts of each alternative, and table 5 analyzes how the alternatives meet the project objectives (as identified in the "Purpose of and Need for Action" chapter). These three tables are located at the end of this chapter.

ALTERNATIVE A – REINSTATE PWC USE UNDER A SPECIAL REGULATION AS PREVIOUSLY MANAGED

Under alternative A, a special regulation would be written to reinstate PWC in accordance with NPS *Management Policies* (NPS 2000c), park practices as specified in the *Superintendent's Compendium* (NPS n.d.), and state regulations with no added restrictions after November 6, 2002.

Equipment and Emissions. As noted in the introduction, the Environmental Protection Agency promulgated a rule to control exhaust emissions from new marine engines, including outboard and PWC engines. Emission controls provide for increasingly stricter standards beginning in model year 1999 (EPA 1996a, 1997). Under this alternative, it is assumed that over time, PWC two-stroke engines would be converted to cleaner direct-injection or four-stroke engines in accordance with industry compliance with the EPA rule (40 CFR Parts 89-91, "Air Pollution Control; Gasoline Spark-Ignition and Spark-Ignition Engines," Exemptions; Rule, 1996). It is the responsibility of the PWC industry to meet these rules, not the responsibility of individual PWC owners.

Areas of Use / Location Restrictions. The following areas would remain closed to PWC operations:

- Gated area south of Yellowtail Dam's west side to spillway entrance works, and Bighorn River from Yellowtail Dam to cable 3,500 feet north;
- At Afterbay Dam – from fenced areas on west side of dam;
- Afterbay Lake – Area between dam intake works and buoy/cable line 100 feet west;
- Government docks as posted;
- At Ok-A-Beh gas dock (customers excepted) and;
- From Yellowtail Dam upstream to the log boom.

Docking would be limited at courtesy docks at Ok-A-Beh, Barry's Landing, Horseshoe Bend, and at the Box Canyon Comfort Station Dock (exclusive of adjacent slips) to 15 minutes (official and concession vessels excepted); and Crooked Creek Bay would be closed to towing of people and personal watercraft use (refer to map 2 following the tables at the end of this chapter).

Wake Restrictions. Montana state regulations stipulate that flat-wake speed must be maintained when within 200-feet of a dock, swimmer, swimming raft, non-motorized boat or anchored vessel. Wyoming state regulations stipulate that no person operating a personal watercraft shall cross or jump the wake of another watercraft when within one hundred (100) feet of the watercraft creating the wake. In addition, NPS wake restrictions are in effect in several areas of the lake and the affected area is marked by buoys.

Safety / Operating Restrictions. Montana and Wyoming State laws would continue to apply to personal watercraft operators. The National Park Service is not instituting flat-wake regulations at Bighorn Lake; however, speed and proximity restrictions are administered according to state regulations. Both states define personal watercraft as boats or watercraft when addressing safe operations, the registering and numbering of vessels, and noise limitations (Montana). More specifically, the state of Montana requires that:

- All operators and riders to wear U.S. Coast Guard approved personal flotation devices (PFD).
- If the personal watercraft is equipped with a lanyard-type cord that shuts off the engine if the operator falls off the craft, the lanyard must be attached to the operator's wrist or personal flotation device.
- A "no wake" speed must be maintained when within 200-feet of a dock, swimmer, swimming raft, non-motorized boat or anchored vessel.
- Stand-up personal watercraft and personal watercraft towing a water skier must travel at a minimum speed necessary to operate when leaving from or returning to a dock or shore.
- Children 12 years old or younger may not operate a motorboat or a personal watercraft powered by a motor rated at more than 10 horsepower unless accompanied by someone 18 years of age or older. Youths 13 and 14 years of age may not operate those vessels without possessing a valid Montana motorboat operator's safety certificate or evidence of completing an approved water safety course, or unless accompanied by someone 18 years of age or older.
- A person must be 18 years or older to rent a motorboat or personal watercraft powered by a motor rated at more than 10 horsepower.

Specifically, the state of Wyoming requires that:

- No person operating a personal watercraft shall cross or jump the wake of another watercraft when within 100 feet of the watercraft creating the wake.
- No person shall operate a personal watercraft unless the watercraft is equipped by the manufacturer with a "kill switch." The kill switch shall be attached via a lanyard to the operator of the personal watercraft when it is underway in such a manner that in the event the operator is ejected from the personal watercraft the engine shall stop.
- All persons aboard personal watercraft shall wear a U.S. Coast Guard approved personal flotation device of a suitable size while engaged in such activity.

- No persons shall operate or be in physical control of a numbered motorboat (this includes personal watercraft) unless the person is at least 16 years of age or accompanied by an adult.

ALTERNATIVE B – REINSTATE PWC USE UNDER A SPECIAL REGULATION WITH ADDITIONAL MANAGEMENT PRESCRIPTIONS

Under this alternative, a special regulation would be written to resume PWC use within Bighorn Canyon. In addition to the equipment and emissions assumptions described under alternative A, the following management actions would be implemented under alternative B.

Areas of Use / Location Restrictions. In addition to those areas closed to PWC use listed in alternative A, this alternative would include a closure of the reservoir and shoreline south of the area known as the South Narrows (legal description R94W, T57N at the SE corner of Section 6, the SW corner of Section 5, the NE corner of Section 7, and the NW corner of Section 8). Bighorn Canyon National Recreation Area would also install buoys to delineate the boundary. Personal watercraft users would be required to stay north of this boundary (refer to map 3 following the tables at the end of this chapter).

Safety / Operating Restrictions. As delineated under alternative A, all applicable State of Montana and State of Wyoming laws would continue to apply to personal watercraft users.

Education. Bighorn Canyon would establish a PWC user education program implemented through vessel inspections, law enforcement contacts, and signing.

NO-ACTION ALTERNATIVE – ALLOW NO PWC USE

Under the no-action alternative, the National Park Service would take no action to reinstate the use of personal watercraft at Bighorn Canyon National Recreation Area, and no special rule would be promulgated to continue personal watercraft use. They would continue the ban on personal watercraft use at Bighorn Canyon National Recreation Area begun in November 2002 (refer to map 4 following the tables at the end of this chapter).

THE ENVIRONMENTALLY PREFERRED ALTERNATIVE

The environmentally preferred alternative is defined by the Council on Environmental Quality (CEQ) as the alternative that best meets the following criteria or objectives, as set out in Section 101 of the *National Environmental Policy Act*:

- Fulfill the responsibilities of each generation as trustee of the environment for succeeding generations.

- Ensure for all Americans safe, healthful, productive, and aesthetically and culturally pleasing surroundings.

- Attain the widest range of beneficial uses of the environment without degradation, risk of health or safety, or other undesirable and unintended consequences.

- Preserve important historic, cultural, and natural aspects of our national heritage and maintain, whenever possible, an environment that supports diversity and variety of individual choice.

- Achieve a balance between population and resource use that will permit high standards of living and a wide sharing of life's amenities.

- Enhance the quality of renewable resources and approach the maximum attainable recycling of depletable resources.

This discussion also summarizes the extent to which each alternative meets Section 102(1) of the *National Environmental Policy Act*, which asks that agencies administer their own plans, regulations, and laws so that they are consistent, to the fullest extent possible, with the policies outlined above.

Alternative A would satisfy the majority of the six requirements detailed above; however, alternative A would not attain the widest range of beneficial uses of the environment without degradation, risk of health or safety, or other undesirable and unintended consequences because of the potential impacts of PWC use to some visitor experiences, natural resources, and other opportunities in the national recreational area. For this reason, alternative A is not preferred from an environmental perspective.

Alternative B would have impacts on the national recreational area's natural resources similar to those under alternative A. However, alternative B would better meet park goals with respect to the protection of visitor experience and wildlife habitat by prohibiting PWC activities south of the Narrows. In the long term, this alternative would help visitors enjoy a beneficial use by allowing access to national recreation area amenities by PWC users while accommodating passive outdoor recreationists and meeting resource management objectives. This alternative would accommodate recreational opportunities for visitors while protecting sensitive natural resources. Alternative B is designed to meet the general prohibition on PWC use by the National Park Service for the protection of park resources and values while continuing to provide recreational opportunities for PWC users in non-sensitive areas.

The no-action alternative would ensure a safe, healthful, productive, and aesthetically and culturally pleasing area for visitors to access without the threat of PWC users introducing noise and safety concerns. The no-action alternative would attain the widest range of beneficial uses of the environment without degradation, risk of health or safety, or other undesirable and unintended consequences by removing the PWC use from the national recreation area entirely. However, the no-action alternative would not maintain an environment that supports diversity and variety of individual choice, nor would it achieve a balance between population and resource use that permits a wide sharing of amenities.

Based on the analysis prepared for PWC use at Bighorn Canyon National Recreation Area, alternative B is considered the environmentally preferred alternative by best fulfilling park responsibilities as trustee of sensitive habitat; by ensuring safe, healthful, productive, and aesthetically and culturally pleasing surroundings; and by attaining a wider range of beneficial uses of the environment without degradation, risk of health or safety, or other undesirable and unintended consequences.

TABLE 3: SUMMARY OF ALTERNATIVES

Elements	Alternative A: Reinstate PWC Use under a Special Regulation as Previously Managed	Alternative B: Reinstate PWC Use under a Special Regulation with Additional Management Prescriptions	No-Action Alternative: Allow No PWC Use
Equipment and Emissions	Emission controls provide for increasingly stricter standards beginning in model year 1999 (EPA 1996a, 1997). Under this alternative, it is assumed that over time, PWC two-stroke engines would be converted to cleaner direct-injection or four-stroke engines in accordance with industry compliance with the EPA rule (40 CFR Parts 89-91, "Air Pollution Control; Gasoline Spark-Ignition and Spark-Ignition Engines," Exemptions; Rule, 1996). The EPA engine standards and restrictions apply only to the marine engine and vessel industry and these restrictions would not apply to owners or operators of personal watercraft.	Same as alternative A.	Not applicable
Areas of Use/ Location Restrictions	Allow PWC use as provided and managed under the Superintendent's Compendium. ***The following areas would remain closed:*** Gated area south of Yellowstone Dam's west side to spillway entrance works, and Bighorn River from Yellowtail Dam to cable 3,500 feet north; Yellowtail Dam upstream to the log boom; At Afterbay Dam-from fenced areas on west side of dam; Afterbay Lake-Area between dam intake works and buoy/cable line 100 feet west; Government docks as posted; At Ok-A-Beh gas dock (customers excepted) and; Docking would be limited at courtesy docks at Ok-A-Beh, Barry's Landing, Horseshoe Bend, and at the Box Canyon Comfort Station Dock (exclusive of adjacent slips) to 15 minutes (official and concession vessels excepted); and Crooked Creek Bay would be closed to towing of people and personal water craft use.	Same as alternative A with the reservoir and shoreline south of the area known as the South Narrows (legal description R94W,T57N at the SE corner of Section 6, the SW corner of Section 5, the NE corner of Section 7, and the NW corner of Section 8) closed to PWC use. Bighorn Canyon National Recreation Area would install buoys to delineate boundary. Personal watercraft users would be required to stay north of this boundary.	Personal watercraft use prohibited in the recreation area.
Wake Restrictions	Follow Montana state regulation – no-wake speed must be maintained when within 200-feet of a dock, swimmer, swimming raft, non-motorized boat or anchored vessel – and Wyoming state regulation – no person operating a personal watercraft shall cross or jump the wake of another watercraft when within one hundred (100) feet of the watercraft creating the wake. In addition, NPS wake restrictions are in effect in several areas of the lake and the affected area is marked by buoys.	Same as alternative A.	Not applicable

TABLE 3: SUMMARY OF ALTERNATIVES

Elements	Alternative A: Reinstate PWC Use under a Special Regulation as Previously Managed	Alternative B: Reinstate PWC Use under a Special Regulation with Additional Management Prescriptions	No-Action Alternative: Allow No PWC Use
Launch Restrictions	There are two marinas: Horseshoe Bend and Ok-A-Beh. Both provide gas, rental docks, food, and boater supplies from Memorial Day through Labor Day. Watercraft can also enter the lake at Barry's Landing. Other access is limited due to shallow water and high cliffs.	Same as alternative A.	No launching or retrieval of personal watercraft permitted.
Safety / Operating Restrictions			
Age Restrictions	Abide by Montana regulations – children 12 years old or younger may not operate a motorboat or a personal watercraft powered by a motor rated at more than 10 horsepower unless accompanied by someone 18 years of age or older. Youths 13 and 14 years of age may not operate those vessels without possessing a valid Montana motorboat operator's safety certificate or evidence of completing an approved water safety course, or unless accompanied by someone 18 years of age or older – and Wyoming regulation – no persons shall operate or be in physical control of a numbered motorboat (this includes personal watercraft) unless the person is at least sixteen (16) years of age or accompanied by an adult.	Same as alternative A.	Not applicable
Flotation Devices	Abide by Montana and Wyoming regulations that require all personal watercraft operators and riders to wear U.S. Coast Guard approved personal flotation devices.	Same as alternative A.	Not applicable
Lanyard-Cutoff	Abide by Montana and Wyoming regulations that operators must fasten lanyard-cut-off device to rider if personal watercraft has one.	Same as alternative A.	Not applicable
Time Restrictions	No time restrictions mandated by Montana or Wyoming regulations. No data is available regarding the operating hours of personal watercraft at Bighorn Canyon National Recreation Area, though most personal watercraft probably operate between the hours of dawn to dusk.	Same as alternative A.	No use of personal watercraft permitted at any time.

TABLE 3: SUMMARY OF ALTERNATIVES

Elements	Alternative A: Reinstate PWC Use under a Special Regulation as Previously Managed	Alternative B: Reinstate PWC Use under a Special Regulation with Additional Management Prescriptions	No-Action Alternative: Allow No PWC Use
Speed Restrictions	No general speed restrictions mandated by Montana or Wyoming regulations. Montana regulations do state that (1) stand-up personal watercraft and personal watercraft towing a water skier must travel at a minimum speed necessary to operate when leaving from or returning to a dock or shore and (2) a "no wake" speed must be maintained when within 200-feet of a dock, swimmer, swimming raft, non-motorized boat or anchored vessel. Although some personal watercraft can reach speeds in the 60-mph range, most do not at Bighorn Canyon National Recreation Area due to the lake's configuration (lack of long stretches). There are few accesses to shallow-draft areas, which can create wakes that pose a conflict and safety hazard to other users, such as canoeists or kayakers.	Same as alternative A.	Not applicable
Education	None.	Implement user education through vessel inspections, law enforcement contacts, and signing.	Educate visitors on why personal watercraft are prohibited from recreation area.

TABLE 4: SUMMARY OF ENVIRONMENTAL CONSEQUENCES

Impact Topic	Alternative A: Reinstate PWC Use under a Special Regulation as Previously Managed	Alternative B: Reinstate PWC Use under a Special Regulation with Additional Management Prescriptions	No- Action Alternative: Allow No PWC Use
Water Quality	Alternative A would have negligible long-term adverse effects on water quality based on ecotoxicological threshold volumes due to the reinstatement of PWC use. All cumulative pollutant loads in 2002 and 2012 from personal watercraft and other motorboats would be neglegible, and would be well below ecotoxicological benchmarks and criteria. Adverse water quality impacts from PWC from benzo(a)pyrene, benzene and MTBE based on human health (ingestion of water and fish) benchmarks would be negligible in both 2002 and 2012, based on water quality criteria set by the Environmental Protection Agency, as well as water quality criteria for Wyoming and Montana. Cumulative impacts from personal watercraft and other watercraft would be negligible, adverse and long-term for benzo(a)pyrene, benzene and MTBE. Implementation of this alternative would not result in an impairment of the water quality resource.	The adverse impacts to water quality from alternative B would be the same as alternative A. Closure of the SouthNarrows area to PWC use would not measurably change water quality impacts because the water levels in this area are generally below the elevation of launch facilities in an average year. PWC use under alternative B would have negligible adverse effects on water quality based on ecotoxicological threshold volumes. All pollutant loads in 2002 and 2012 from personal watercraft and other motorboats would be neglibible and well below ecotoxicological benchmarks and criteria. Adverse water quality impacts from PWC from benzo(a)pyrene, benzene and MTBE based on human health (ingestion of water and fish) benchmarks would be negligible in both 2002 and 2012, based on water quality criteria set by the Environmental Protection Agency as well as water quality criteria for Wyoming and Montana. Cumulative adverse impacts from personal watercraft and other watercraft would be negligible for benzo(a)pyrene, benzene and MTBE. Implementation of this alternative would not result in an impairment of the water quality resource.	The no-action alternative would have a beneficial impact on water quality. Pollutant loads from personal watercraft would be eliminated. Cumulative impacts from the remaining motorboats would be negligible adverse in 2002 and 2012 for all ecotoxicological and human health benchmarks. Implementation of this alternative would not result in an impairment of the water quality resource.
Air Quality	Alternative A would result in negligible adverse impacts to human heath related to the PWC airborne pollutants CO, PM_{10}, HC and NO_x. The risk from PAH would also be negligible adverse. In 2012, there would be an increase in NO_x emissions and a decrease in emissions of the other pollutants; however, the impact level for these pollutants would remain negligible. Cumulative emission levels from boating and PWC use at Bighorn Canyon would be negligible adverse for PM_{10}, HC and NO_x, and minor adverse for CO in 2002 and 2012. CO and NO_x emissions would increase from 2002 to 2012 because of increased boating activity and cleaner engines that have higher CO and NO_x emissions. Although there would be an increase in NO_x emissions	Alternative B would result in the same air quality impacts to human health from PWC emissions as alternative A because additional PWC management strategies would not noticeably affect PWC emissions. As in alternative A, negligible adverse impacts for CO, HC, PM_{10} and NO_x would occur for 2002 and 2012. The risk from PAH would also be negligible adverse in 2002 and 2012. Cumulative adverse impacts from PWC and other boating emissions at Bighorn Canyon would be minor for CO and negligible for PM_{10}, HC, and NO_x in 2002. In 2012, impacts for the all pollutants would remain at 2002 levels although a beneficial impact to regional ozone emissions would occur due to a reduction in HC emissions. PWC contribution to emissions of HC are estimated to be 14% of the	Continuing the ban on PWC use at Bighorn Canyon National Recreation Area would result in beneficial impacts on human health relative to the other alternatives for CO, HC, PM_{10} and NO_x for the years 2002 and 2012 because PWC emissions would be eliminated. The risk from PAH would also be eliminated in 2002 and 2012. Cumulative adverse impacts to human health from airborne pollutants in 2002 would be negligible for all pollutants analyzed. In 2012, adverse impacts to human health from boating emissions would remain negligible for PM_{10}, HC and NO_x, while the impact for CO would increase from negligible to minor. Increased CO emissions and slightly increased NO_x emissions in 2012 would result from increased

TABLE 4: SUMMARY OF ENVIRONMENTAL CONSEQUENCES

Impact Topic	Alternative A: Reinstate PWC Use under a Special Regulation as Previously Managed	Alternative B: Reinstate PWC Use under a Special Regulation with Additional Management Prescriptions	No- Action Alternative: Allow No PWC Use
	in 2012, the greater reduction in HC emissions would result in a beneficial impact to regional ozone concentrations and would maintain or improve existing air quality conditions. Overall, PWC emissions of HC are estimated to be 14% of the cumulative boating emissions in 2002 and 2012. Implementation of this alternative would not result in an impairment of air quality.	cumulative boating emissions in 2002 and 2012. Implementation of this alternative would not result in an impairment of air quality.	boating activity and the conversion to new technology engines. The reductions in HC emissions would contribute to a beneficial impact to regional ozone levels. The risk from PAH would also be negligible in 2002 and 2012. Implementation of this alternative would not result in impairment of air quality.
Air Quality Related Values from PWC Pollutants	Negligible adverse impacts to air quality related values would occur from PWC emissions in 2002 and 2012. This conclusion is based on pollutant emissions of less than 50 tons per year, no observed visibility impacts or ozone-related plant injury, and low regional SUM06 values. Cumulative emissions from motorized boats and PWC in both 2002 and 2012 would result in negligible adverse impacts to air quality related values. Beneficial effects to ozone levels would occur in 2012 resulting from the expected reduction in HC emissions from new engine technology. Implementation of this alternative would not result in an impairment of air quality related values.	The impacts of alternative B would be the same as alternative A because additional PWC management strategies would not affect personal watercraft emissions. Alternative B would have negligible adverse impacts to air quality related values from PWC and from cumulative emissions of PWC and motorized boats in both 2002 and 2012. This conclusion is based on calculated levels of pollutant emissions and the low SUM06 values. There are no observed visibility impacts or ozone-related plant injury in the recreation area. Implementation of this alternative would not result in an impairment of air quality related values.	HC, NO_x, and $PM_{2.5}$ emissions would be reduced due to a continued ban on PWC use resulting in negligible impacts to air quality related values from non-PWC watercraft in both 2002 and 2012. This conclusion is based on regional SUM06 values, the lack of existing or anticipated local ozone or visibility effects, and the calculated pollutant emission levels. Implementation of this alternative would not result in an impairment of air quality related values.
Soundscapes	Noise from PWC would have minor to moderate adverse impacts over the short and long-term at most locations on Bighorn Lake and immediate surrounding area. Impacts would be related to the number of personal watercraft operating as well as the sensitivity of other visitors. Cumulative noise impacts from personal watercraft, motorboats, and other visitors would be minor to moderate adverse impacts over the short and long-term because these sounds would be heard occasionally throughout the day, and may predominate on busy days during the high use season. Implementation of this alternative would not result in an impairment of soundscape values.	Alternative B would result in a negligible to moderate adverse impact on the national recreation area soundscape. PWC impacts would be negligible south of the South Narrows due to geographic restriction of PWC in this area. Minor and moderate PWC noise impacts would occur in the areas of the national recreation area north of the South Narrows. Impacts would generally be short-term, although could periodically be longer-term at shoreline areas on the very high use days, where motorized noise may predominate off and on for most of the day. Cumulative noise impacts from personal watercraft, motorboats, and other visitors would be minor to moderate because these sounds would be heard occasionally throughout the day, and may predominate on busy days during the high use season. Implementation of this alternative would not result in an impairment of soundscape values.	The continued ban on PWC would result in a decrease in noise experienced at the national recreation area. Contributions of PWC to cumulative impacts would be eliminated. Cumulative noise impacts from other motorized watercraft and other visitor activities would be the same as in alternatives A and B. Cumulative impact would continue to be minor to moderate adverse in the short and long-term. This alternative would not result in an impairment of soundscape values.

TABLE 4: SUMMARY OF ENVIRONMENTAL CONSEQUENCES

Impact Topic	Alternative A: Reinstate PWC Use under a Special Regulation as Previously Managed	Alternative B: Reinstate PWC Use under a Special Regulation with Additional Management Prescriptions	No- Action Alternative: Allow No PWC Use
Wildlife and Wildlife Habitat	PWC use would have negligible to minor adverse impacts on fish, waterfowl, and other wildlife. There would be no perceptible changes in wildlife populations or their habitat community structure. Due to low levels of PWC use in the recreation area, coupled with a lack of habitat in areas of frequent PWC use, any impacts to fish, wildlife and respective habitats would be temporary and short term. The intensity and duration of impacts is not expected to increase substantially over the next 10 years, since PWC numbers would not increase substantially and engine technology would continue to improve under EPA industry regulations. Cumulative impacts from visitor activities would have short-term, minor to moderate adverse effects on wildlife and wildlife habitat. Lake operations and drought cycles also contribute to cumulative impacts through fluctuations in water level and potentially would cause short to long-term minor to moderate adverse impacts to fish, and beneficial or adverse impacts to riparian and wetland areas that provide habitat for wildlife. Implementation of this alternative would not result in impairment to wildlife or wildlife habitat.	The reinstatement of PWC use with additional management prescriptions and education efforts would have beneficial impacts to wildlife due to the decreased noise and disturbance from PWC. Although reduced, impacts to wildlife and wildlife habitat from PWC use would remain adverse negligible to minor in 2002 and 2012, similar to alternative A. All wildlife impacts from personal watercraft would be temporary and short term. Cumulative adverse impacts from visitor activities would be minor to moderate as under alternative A. Lake level fluctuations would also contribute to cumulative adverse impacts through minor to moderate levels of short to long-term habitat disturbance. Implementation of this alternative would not result in impairment to wildlife or wildlife habitat.	PWC use would not be reinstated on Bighorn Lake, resulting in beneficial impacts to wildlife and wildlife habitat due to the reduction of interactions between PWC users and wildlife within the national recreation area. Cumulative adverse impacts on wildlife and wildlife habitat would be short-term, minor to moderate due to visitor activities and short to long-term, minor to moderate from lake level fluctuations. The contribution of PWC use to overall adverse impacts to wildlife and wildlife habitat would be eliminated. Implementation of this alternative would not result in impairment to wildlife or wildlife habitat.
Threatened, Endangered, or Special Concern Species	PWC use at Bighorn Canyon may affect, but is not likely to adversely affect, the following species with federal or state protection status: bald eagle, Rocky Mountain bighorn sheep, American peregrine falcon, Townsend's big-eared bat, northern leopard frog, or persistent sepal yellowcress. There would be no effect to all other federal or state listed species, including mountain plover, plains spadefoot toad, Hapeman's sullivantia, Lesica's bladderpod, sweetwater milkvetch, or rabbit buckwheat. The identified special status species are either not permanent residents and not present during times of PWC use, are not usually accessible, are generally acclimated to human activity, or do not have preferred habitat in the areas used by PWC. Similarly, cumulative effects from all national recreation area visitor activities and lake level	Under alternative B, PWC use at Bighorn Lake may affect, but would not likely adversely affect, special status species including Rocky Mountain bighorn sheep, American peregrine falcon, Townsend's big-eared bat, or northern leopard frog. However, the potential for impacts to these species would be reduced relative to alternative A due to the decreased area of allowed PWC use and increased PWC user education efforts. Potential effects to the bald eagle and persistent sepal yellowcress would be eliminated by the closure of the area south of the South Narrows to PWC use and no effects from PWC would occur to these species under this alternative. There would be no PWC-caused effects to all other federal or state listed species including the mountain plover, plains spadefoot toad, Hapeman's sullivantia,	PWC users would not be allowed to operate on Bighorn Lake, resulting in an elimination of PWC related effects to special status species and habitat relative to alternatives A and B. However, since PWC use at the recreation is minimal, cumulative effects from lake operations, non-PWC watercraft use, and other visitor activities would be similar and overall effects would remain the same as other alternatives. The no-action alternative may affect, but is unlikely to affect special status species in the national recreation area. Implementation of this alternative would not result in an impairment of threatened or endangered species.

TABLE 4: SUMMARY OF ENVIRONMENTAL CONSEQUENCES

Impact Topic	Alternative A: Reinstate PWC Use under a Special Regulation as Previously Managed	Alternative B: Reinstate PWC Use under a Special Regulation with Additional Management Prescriptions	No- Action Alternative: Allow No PWC Use
	fluctuations may affect, but would not likely adversely affect, special status species, due to lack of species occurrences and access to their habitats. Implementation of this alternative would not result in an impairment of threatened or endangered species.	Lesica's bladderpod, sweetwater milkvetch, or rabbit buckwheat as in alternative A. All impacts to special status species would be temporary and short term. Cumulative impacts may affect but would not be likely to adversely affect special status species and would result from lake level fluctuations as well as visitor activities that are concentrated mostly in developed areas rather than in habitat for special status species. Implementation of this alternative would not result in an impairment of threatened or endangered species.	
Shorelines and Shoreline Vegetation	PWC use would result in negligible short-term adverse effects on shoreline vegetation due to low PWC use and the lack of shoreline vegetation due to the canyon environment present throughout the majority of the national recreation area. According to visitor use patterns, sensitive wetland and riparian communities are located in areas not often utilized by PWC due to accessibility issues related to water level cycles. Cumulative adverse impacts from other watercraft and visitor activities would be negligible to minor and short-term. Lake level fluctuations from drought or lake operations would potentially have minor to moderate adverse impacts to sensitive vegetation in the Yellowtail Wildlife Habitat area. Implementation of this alternative would not result in an impairment of shoreline vegetation.	Reduced PWC access would eliminate adverse impacts in the southernmost portion of the national recreation area during times when there are sufficient water levels to provide access by PWC, resulting in beneficial impacts to sensitive shoreline vegetation. Cumulative adverse impacts from PWC and other watercraft use and visitor activities would remain negligible to minor, while impacts from lake level fluctuations would remain minor to moderate. Implementation of this alternative would not result in an impairment of shoreline vegetation.	PWC would not be allowed to operate on Bighorn Lake, resulting in beneficial impacts to shoreline vegetation. Cumulative impacts from other watercraft activity and visitor activities would continue, and would be negligible to minor. Lake fluctuations due to lake operations or drought would have minor to moderate adverse impacts on sensitive shoreline vegetation. PWC contribution to these impacts would be eliminated. Implementation of this alternative would not result in an impairment of shoreline vegetation.
Visitor Use and Experience	Under this alternative a negligible to minor adverse impacts on experiences for most visitors in the short and long term would occur. Swimmers and other visitors seeking natural quiet would be most affected by PWC use, especially at the designated swim beaches and within the canyon section of the national recreation area. PWC use would have long-term, minor to moderate adverse impacts on those visitors desiring natural quiet. PWC use would have negligible adverse impacts on other boaters due to increased congestion at popular boat launches. Most visitors would	Designation of the closed area south of the South Narrows would have a negligible adverse impact on most PWC users since this area has not had high PWC use, and most of the reservoir would still be open for use. Other boaters and all shoreline users would experience negligible adverse impacts north of the South Narrows and beneficial impacts south of the South Narrows. Cumulative effects of PWC use, other watercraft, and other visitors would result in long-term, negligible adverse impacts.	The no-action alternative would have a beneficial impact on the experiences of most non-PWC using visitors to the recreation area. Impacts on PWC users would be long term, minor, and adverse. Cumulative effects of PWC use, other watercraft, and other visitors would result in short- and long-term negligible impacts.

TABLE 4: SUMMARY OF ENVIRONMENTAL CONSEQUENCES

Impact Topic	Alternative A: Reinstate PWC Use under a Special Regulation as Previously Managed	Alternative B: Reinstate PWC Use under a Special Regulation with Additional Management Prescriptions	No- Action Alternative: Allow No PWC Use
	experience negligible to minor adverse effects under this alternative and would be satisfied with their experiences. Cumulative effects of PWC use, other watercraft, and other visitors would result in short- and long-term, negligible adverse impacts.		
Visitor Conflicts and Safety	Reinstated PWC use would have negligible to minor adverse impacts over the short and long term related to visitor conflicts and safety issues. Conflicts would mostly occur at high use areas such as Horseshoe Bend and Ok-A-Beh between personal watercraft and other watercraft. Conflicts at other locations would remain negligible because use is lower and conflicts would be less likely to occur. Cumulative impacts related to visitor conflicts and safety would be negligible adverse for all user groups in the short and long term. Overall, most visitors would experience negligible to minor adverse effects under this alternative and would be satisfied with their experiences.	Reinstated PWC use with the management prescriptions of alternative B would have beneficial impacts on visitor conflict and safety goals south of the South Narrows. North of the South Narrows impacts on visitor conflict and safety goals would be negligible adverse. Cumulative impacts related to visitor conflicts and safety would be negligible to minor adverse for all user groups in the short and long term, particularly near the high use areas.	Continuing to ban PWC use would have a beneficial impact on the visitor conflict and safety goals of swimmers, other boaters, and all other visitors. Cumulative impacts related to visitor conflicts and safety would be negligible adverse for all user groups in the short and long term.
Cultural Resources	PWC use within the national recreational area could have minor adverse impacts in the short and long term on listed or potentially listed archeological sites from possible illegal collection and vandalism. Cumulative impacts on archeological resources that are readily accessible could be minor to major adverse over the short and long term, due to the number of visitors and the potential for illegal collection or destruction. Implementation of this alternative would not result in an impairment of cultural resources.	Closing the South Narrows could have beneficial impacts on potentially listed archeological resources from possible illegal collection and vandalism. Cumulative impacts of other activities on archeological resources that are readily accessible could be minor to major and adverse over the short and long term, due to the number of visitors and the potential for illegal collection or destruction. Implementation of this alternative would not result in an impairment of cultural resources.	Prohibiting PWC use would have beneficial impacts over the short and long term on archeological sites. Adverse cumulative impacts from all visitor activities would be minor to major over the short and long term, depending on the accessibility of the resource and the potential for illegal collection or damage. Implementation of this alternative would not result in an impairment of cultural resources.
Socioeconomic Effects	Socioeconomic impacts would be negligible under alternative A.	Socioeconomic impacts would be negligible under alternative B.	Socioeconomic impacts would be negligible under the no-action alternative.

TABLE 4: SUMMARY OF ENVIRONMENTAL CONSEQUENCES

Impact Topic	Alternative A: Reinstate PWC Use under a Special Regulation as Previously Managed	Alternative B: Reinstate PWC Use under a Special Regulation with Additional Management Prescriptions	No- Action Alternative: Allow No PWC Use
National Recreation Area Management and Operations	This alternative would have negligible adverse impacts on park operations and enforcement would continue at current levels. Implementation of this alternative would not result in an impairment to park operations.	Alternative B would have negligible to minor adverse impacts on park operations. Staffing would continue at current levels, though increased enforcement efforts would be required to implement additional prescriptions. Additional educational efforts would also be required to inform PWC users of new regulations. Implementation of this alternative would not result in an impairment to park operations.	This alternative would have minor adverse impacts on park operations. No additional staff, funding, or equipment beyond what has been requested would be secured to ensure compliance with the PWC ban and to regulate existing boating use. Staff would initially need to spend more time and effort educating visitors until they became fully aware of the PWC ban. Under the no-action alternative, it would be likely that some PWC users would operate illegally within the recreation area. Implementation of this alternative would not result in impairment to park operations.

TABLE 5: ANALYSIS OF HOW ALTERNATIVES MEET OBJECTIVES

Issue	Objective	Alternative A: Reinstate PWC Use under a Special Regulation as Previously Managed	Alternative B: Reinstate PWC Use under a Special Regulation with Additional Management Prescriptions	No-Action Alternative: Allow No PWC Use
Water Quality				
A typical conventional (i.e., carbureted) two-stroke PWC engine discharges as much as 30% of its fuel unburned directly into the water (NPS 1999; CARB 1999). At common fuel consumption rates, an average two-hour ride on a personal watercraft may discharge 3 gallons of fuel into the water (NPS 1999). According to data from the California Air Resources Board, two-stroke PWC engines may consume 5 to 10 gallons of fuel per hour, of which up to 3.3 gallons per hour may be discharged unburned (CARB 1998b). Hydrocarbons, including benzene, toluene, ethyl benzene, and xylene; and PAH are released, as well as MTBE. These discharges have potential adverse effects on water quality.	Manage PWC emissions that enter the water in accordance with NPS anti-degradation policies and goals.	Meets objective through EPA-regulated conversion to cleaner engines (EPA 1996a, 1997).	Meets objective through EPA-regulated conversion to cleaner engines (EPA 1996a, 1997).	Fully meets objective.
Some research shows that PAH, including those from personal watercraft emissions, adversely affect water quality via harmful phototoxic effects on ecologically sensitive plankton and other small water organisms (EPA 1998; Oris et al. 1998; Landrum et al. 1987; Mekenyan et al. 1994; Arfsten et al. 1996).	Protect plankton and other aquatic organisms from PWC emissions so that the viability of dependent species is conserved.	Meets objective through EPA-regulated conversion to cleaner engines (EPA 1996a, 1997).	Meets objective through EPA-regulated conversion to cleaner engines (EPA 1996a, 1997).	Fully meets objective.
Air Quality				
Pollutant emissions, particularly NO_x and HC from personal watercraft, may adversely affect air quality. These compounds react with sunlight to form ozone. To the extent that nitrogen loading in the air contributes to the nutrient loading in the water column, PWC use adversely affects water quality.	Manage PWC activity so that PWC air emissions of harmful compounds do not appreciably degrade ambient air quality.	Meets objective through EPA-regulated conversion to cleaner engines (EPA 1996a, 1997).	Meets objective through EPA-regulated conversion to cleaner engines (EPA 1996a, 1997).	Fully meets objective.

TABLE 5: ANALYSIS OF HOW ALTERNATIVES MEET OBJECTIVES

Issue	Objective	Alternative A: Reinstate PWC Use under a Special Regulation as Previously Managed	Alternative B: Reinstate PWC Use under a Special Regulation with Additional Management Prescriptions	No-Action Alternative: Allow No PWC Use
Soundscapes				
Noise limits established by the National Park Service require vessels to operate at less than 82 dB at 82 feet from the vessel.	Manage noise from PWC use in affected areas so that visitors' health, safety, and experiences are not adversely affected.	Meets objective. New machines may also generate less noise.	Meets objective. New machines may also generate less noise.	Fully meets objective.
Wildlife and Wildlife Habitat				
Some research suggests that PWC use impacts wildlife through interruption of normal activities, alarm or flight; avoidance and displacement of habitat; and effects on reproductive success. This is thought to be caused by a combination of PWC speed, noise and ability to access sensitive areas, especially in shallow-water depths. Literature suggests that personal watercraft can access sensitive shorelines, disrupting riparian habitat areas critical to wildlife.	Protect fish and wildlife (including threatened or endangered species) and their habitats from PWC disturbances.	Meets objective, with PWC use concentrated around developed launch and recreational facilities.	Meets objective, with Yellowtail Wildlife Habitat area restricted from PWC access.	Fully meets objective.
Some research suggests that personal watercraft have a greater impact on waterfowl and nesting birds because of their noise, speed, and ability to access shallow-water areas more readily than other types of watercraft. This may force nesting birds to abandon eggs during crucial embryo development stages and flush other waterfowl from habitat, causing stress and associated behavior changes.	Protect birds, waterfowl, and other wildlife from the effects of PWC noise.	Meets objective. New machines may also generate less noise.	Meets objective. New machines may also generate less noise.	Fully meets objective.
Threatened and Endangered Species				
Similar to wildlife, personal watercraft may affect federally listed or other species of concern through interruption of normal activities; alarm or flight; avoidance and displacement of habitat; and effects on reproductive success. At Bighorn Canyon, bald eagle, bighorn sheep, and peregrine falcon are special status species that could potentially be impacted by personal watercraft. In some areas, PWC use is believed to cause harm to	Protect threatened and endangered species, and species of special concern, and their habitats from PWC disturbances.	Meets objective. PWC use is concentrated around developed launch and recreational facilities within Bighorn Canyon, which are not typically areas of threatened, endangered, or species of concern use. Bighorn sheep, which potentially utilize these areas, have become acclimated to human caused disturbances. PWC use in other areas	Meets objective. The Yellowtail Wildlife Habitat area, the main habitat area for waterfowl and wildlife within Bighorn Canyon, is formally restricted from PWC access and therefore potential disturbance to bald eagles from PWC use in the area south of the South Narrows is eliminated. Bighorn sheep, which may be found near areas of	Fully meets objective.

TABLE 5: ANALYSIS OF HOW ALTERNATIVES MEET OBJECTIVES

Issue	Objective	Alternative A: Reinstate PWC Use under a Special Regulation as Previously Managed	Alternative B: Reinstate PWC Use under a Special Regulation with Additional Management Prescriptions	No-Action Alternative: Allow No PWC Use
threatened and endangered species because the machine's engine, submerged under the water, muffles the 'warning' sounds some species depend on to escape from imminent danger.		of Bighorn Canyon, including the area south of the South Narrows, is infrequent and unlikely to affect any threatened, endangered, or species of concern, including the bald eagle which nests in the area.	PWC use, have become acclimated to human caused disturbances and would not be affected by PWC use.	
Shoreline Vegetation				
PWC are able to access areas such as shallow waters where most other watercraft cannot go, which may result in disturbance of sensitive plant species. In addition, PWC may land on the shoreline, allowing visitors to access areas where sensitive vegetation and plant species exist.	Manage PWC use to protect sensitive shoreline areas (vegetation / erosion) from PWC activity and access.	Meets objective. PWC use is primarily concentrated around developed launch and recreational facilities within Bighorn Canyon, which do not support sensitive shoreline vegetation. The Yellowtail Wildlife Habitat area, the main location for potentially sensitive shoreline vegetation within Bighorn Canyon, is not an area of frequent PWC use.	Fully meets objective. The Yellowtail Wildlife Habitat area, the main location for potentially sensitive shoreline vegetation within Bighorn Canyon, is formally restricted from PWC access. As a result, potential disturbances to shoreline vegetation from PWC users in the area south of the South Narrows are eliminated.	Fully meets objective.
Visitor Use and Experience				
Some research suggests that personal watercraft are viewed by some segments of the public as a 'nuisance' due to their noise, speed and overall environmental effects, while others believe personal watercraft are no different than other watercraft and that users have a "right" to enjoy the sport.	Minimize potential conflicts between PWC use and park visitors.	Meets objective due to low reported visitor conflict and continued use of personal watercraft.	Meets objective due to low reported visitor conflict and continued use of personal watercraft.	Does not meet objective. Would lower the satisfaction of PWC owners.
Some states and local governments have taken action, or are considering taking action, to limit, ban and otherwise manage PWC use. While the national recreation area may be 'exempt' from these local actions, consistency with state and local plans must be considered. The states of Montana and Wyoming have PWC regulations that provide guidelines for PWC operation and safety at Bighorn Canyon.	Seek cooperation with state entities that regulate PWC use.	Meets objective. No conflicts between state and local regulations.	Meets objective. No conflicts between state and local regulations.	Meets objective. No conflicts between state and local regulations.

TABLE 5: ANALYSIS OF HOW ALTERNATIVES MEET OBJECTIVES

Issue	Objective	Alternative A: Reinstate PWC Use under a Special Regulation as Previously Managed	Alternative B: Reinstate PWC Use under a Special Regulation with Additional Management Prescriptions	No-Action Alternative: Allow No PWC Use
Visitor Conflict and Visitor Safety				
Industry representatives report that PWC accidents decreased in some states in the late 1990s. The National Transportation Safety Board reported that in 1996 personal watercraft represented 7.5% of state-registered recreational boats but accounted for 36% of recreational boating accidents. In the same year PWC operators accounted for more than 41% of people injured in boating accidents. PWC operators accounted for approximately 85% of the persons injured in accidents studied in 1997 (NTSB 1998). In part, this is believed to be a "boater education" issue (for example, inexperienced riders lose control of the craft) and also a function of the PWC operation, that is, no brakes or clutch. When drivers let up on the throttle to avoid a collision, manual steering becomes difficult.	Minimize or reduce the potential for PWC user accidents.	Meets objective. There has only been one accident involving PWC between 1995 and 2002.	Meets objective by establishing a voluntary user education program. There has only been one accident involving PWC between 1995 and 2002.	Fully meets objective.
Due to their ability to access shallow-draft areas, personal watercraft can create wakes that pose a conflict for both shore and boat fishermen and a safety hazard to other users such as canoeists, kayakers and windsurfers.	Minimize or reduce the potential safety conflicts between PWC users and other water recreationists.	Meets objective. There has only been one accident involving PWC between 1995 and 2002.	Meets objective by establishing a voluntary user education program. There has only been one accident involving PWC between 1995 and 2002.	Fully meets objective.
Cultural Resources (Section 106)				
Bighorn National Recreation Area has an array of cultural resources listed on or potentially eligible for listing on the National Register of Historic Places (NRHP). The majority of known archeological sites are located above the cliffs and on the Crow Indian Reservation. There are some sites on the cliff walls but they are difficult to access. Submerged sites approximately 80-feet below the water are known to exist; however, lakes levels do not fluctuate enough to expose such sites.	Manage PWC use and access to protect cultural resources including sacred sites important to Native Americans.	Meets objective through existing management program.	Meets objective with closing of South Narrows and education program.	Fully meets objective.

TABLE 5: ANALYSIS OF HOW ALTERNATIVES MEET OBJECTIVES

Issue	Objective	Alternative A: Reinstate PWC Use under a Special Regulation as Previously Managed	Alternative B: Reinstate PWC Use under a Special Regulation with Additional Management Prescriptions	No-Action Alternative: Allow No PWC Use
Socioeconomic Environment				
National PWC ownership increased every year between 1991 and 1998; the rate of annual increase peaked in 1994 at 32% and dropped slightly in 1999, 2000, and 2001.	Work cooperatively with concessioners and local businesses that rent or sell personal watercraft.	Meets objective. No local businesses impacted.	Meets objective. No local businesses impacted.	Does not meet objective because lack of PWC sales or rentals would result in slightly reduced expenditures by PWC users.
National Recreation Area Management and Operations				
Some states and local governments have taken action, or are considering taking action, to limit, ban, or otherwise manage PWC use. While the national recreation area may be exempt from these local actions, consistency with state and local plans must be evaluated.	Seek cooperation with state entities that regulate PWC use.	Meets objective with federal, state, and local cooperation.	Meets objective with federal, state, and local cooperation.	Fully meets objective.
PWC use may require additional park staff to enforce standards, limits, or closures because of increased accident rates and visitor conflicts.	Provide a safe and healthful park environment for park visitors.	Meets objective. Increase in use may result in increased patrol needs.	Meets objective.	Meets objective.

Map 2: Alternative A: Reinstate PWC Use under a Special Regulation as Previously Managed

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Map 3: Alternative B: Reinstate PWC Use under a Special Regulation with Additional Management Prescriptions

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Map 4: No-Action Alternative: Allow No PWC Use

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AFFECTED ENVIRONMENT

Bighorn Canyon National Recreation Area was established by Act of Congress, (Public Law 89-64, 16 USC 460t.), on October 15, 1966. The recreation area currently includes approximately 120,000 acres including 12,700 acres of Bighorn Lake. Approximately 56,000 acres within the national recreation area and lying within the Crow Indian reservation are closed to public use. Bighorn Lake was created by the Yellowtail Dam, which was constructed on Bighorn River in 1965 as a part of the Missouri River basin Project by the Bureau of Reclamation.

Bighorn Canyon National Recreation Area is a narrow strip of land stretching 60 miles along the Bighorn River corridor from northern Wyoming north into southern Montana. The recreation area is surrounded by hundreds of thousands of acres of Crow Indian Reservation, National Forest, Bureau of Land Management, and relatively undeveloped private lands. The recreation area lies within an area of great scenic diversity, where the Middle Rocky Mountains spill onto the Great Plains, with desert basins, prairie uplands, forested mountains, deep canyons, and Bighorn Lake. The construction of Yellowtail Dam in 1966 provided this semiarid locale and variable stream with expanded water-based recreation opportunities.

The recreation area has two distinct units: the southern end is the widest section of Bighorn Lake and is over two miles across at its widest and almost nine miles long (when water levels are normal to high). The northern 55-mile section is a straight-walled, narrow, 1,000-foot deep winding canyon, with several overlooks. There are two visitor centers and other developed facilities in Fort Smith, Montana and near Lovell, Wyoming; and two marinas and three boat launch areas along the lake.

WATER QUALITY

PHYSICAL CHARACTERISTICS OF BIGHORN LAKE

Bighorn Lake is a reservoir formed by the 525 ft high concrete-arch Yellowtail Dam, completed in 1966. The reservoir is approximately 60 miles long. The Yellowtail Dam was designed to impound water for power production, municipal and industrial use, irrigation, flood control, sediment retention, recreation and fish and wildlife enhancement (NPS 1996b).

The drainage area upstream of Yellowtail Dam is 19,647 square miles with the major contributing watersheds being the Bighorn and Shoshone Rivers and their tributaries, as well as several smaller tributaries that enter the Bighorn Lake in the vicinity of the national recreation area. The Shoshone River empties into the upstream portion of the pool of Bighorn Lake and although it comprises only about 12% of the contributing drainage area, it is one of the main contributors of suspended sediment to the reservoir (Lee and Jones 1981). Sediment accumulation in the Horseshoe Bend area of the reservoir from all contributing watersheds is extremely high, and has been estimated to be about 4,000 tons per day (NPS 1996b). In the 17 years following construction of Yellowtail Dam approximately 53,950 acre-feet of sediment has been deposited in its southern end of the reservoir, resulting in a loss of storage capacity of 3.9%. Horseshoe Bend had accumulated the greatest depth of sediment deposition of about 43 feet (NPS 1996b) at a rate of about 3 feet per year (Lee and Jones 1981). The pronounced meander that exists at the bend results in lower flow velocities and, therefore, greater sediment deposition than any other location at the reservoir. As the reservoir narrows immediately to the north of Horseshoe Bend, the rate of sedimentation decreases substantially, and in the northern pool of the reservoir the effects of sedimentation are minimal.

Lakes and reservoirs may be categorized in terms of their trophic status, or the quantity and production of phytoplanktonic algae. Eutrophic lakes contain high levels of phytoplankton and the nutrients phosphorus and nitrogen. Oligotrophic lakes have low productivity of phytoplankton and corresponding low levels of phosphorus and nitrogen. At Bighorn Lake, the waters are eutrophic at the southern end of the reservoir and change progressively downstream to the dam, where conditions are considered oligotrophic (NPS 1996b). The nutrient phosphorus controls the growth of phytoplankton (algae) in the reservoir during the summer months, the source of which originates from runoff from crop, range and forest lands, as well as municipal and industrial wastes.

As a result of eutrophication, light penetration also varies from the southern to the northern portions of the reservoir. Light penetrates only to a depth of 3 feet in the southern end of the reservoir where the pool is eutrophic, to a depth of about 33 feet near the dam where the reservoir is oligotrophic (NPS 1996b).

The water within Bighorn Lake generally exhibits gradually declining temperature with depth during the months of June, July and August. A weakly defined thermocline (depth at which temperature drops substantially in the temperature profile of the lake) is seen at a depth of approximately 200 feet (NPS 1996b).

Bighorn Lake operates with a standard pattern in most years. Water is released from Bighorn Lake in the fall and winter, allowing the reservoir to fill in the spring and early summer from snowmelt runoff. Maximum water elevation is normally seen in the late summer and minimum water elevation occurs during the early spring. This operation pattern results in minimal changes to the surface area of the lake at the north end because of steep canyon walls. However, surface area in the south end of the lake changes dramatically within the operation cycle. When lake levels are high, large shallow areas along the Bighorn and Shoshone Rivers can be inundated, and conversely, when lake levels are low, these areas are dry. Launch facilities in the Horseshoe Bend area are often unusable because the water elevation is well below the elevation of the launch facilities

The top of active conservation pool is 3,614 feet above mean sea level, with a corresponding volume of 829,687 acre-feet and a surface area of 6,915 acres. In comparison, the minimum pool elevation (top of inactive conservation pool) is 3,547 feet above mean sea level with a corresponding volume of 493,584 acre-feet and a surface area of 4,149 acres.

A zone where waters can freely mix occurs above the thermocline and extends to the lake surface. If a minimum pool elevation is assumed (3,547 feet), then the top of the thermocline would be located at an elevation of 3,347 feet. The volume of water at elevation 3,347 is 43,747 acre-feet. Therefore, by subtracting the volume at the thermocline (43,747 acre-feet) from the minimum pool volume (493,584 acre-feet), the remaining volume of 449,837 acre-feet is the effective mixing zone.

The highest lake level recorded after initial filling at Bighorn Lake was 3,652 feet on July 14, 1997 and the lowest level recorded was 3,576.15 feet, on September 9, 2002. The current lake level at Bighorn Lake (March 27, 2003) is 3,577.4 feet above mean sea level. Drought conditions currently exist at Bighorn Lake, with water levels fluctuating around the lowest elevations recorded since the filling of the reservoir. These existing conditions leave the southern portion of Bighorn Lake, from Horseshoe Bend and upstream, without access to launch facilities and with dry lakebed conditions.

WATER QUALITY STANDARDS

Classification of Waters. Water quality is regulated by state agencies, and in the case of Bighorn Lake, both the Wyoming and Montana Departments of Environmental Quality have established water quality standards.

Wyoming. Under the *Wyoming Environmental Quality Act* (Wyoming Statues 35-11-101 through 1304), Water Quality Rules and Regulations, Chapter 1 (WDEQ 2001a) and Wyoming Surface Water Classification List (WDEQ 2001b), water quality standards for the Bighorn River drainage have been established. Under these regulations, Bighorn Lake within the state of Wyoming is designated as a Class 2AB water body. Class 2AB is a subclass of Class 2 waters, and are defined as waters that are known to support fish or drinking water supplies or where those uses are attainable (WDEQ 2001a). These waters are known to:

- Support game fish populations or spawning and nursery areas (at least seasonally) and are designated "cold water" game fishery; and
- Presumed to have sufficient water quality and quantity to support drinking water supplies and are protected for that use.

These waters are protected for the following uses:

- non-game fisheries, fish consumption, and aquatic life other than fish;
- primary contact recreation;
- wildlife;
- industry;
- agriculture; and
- scenic value.

Montana. Water quality in the portion of the recreation area located in Montana is protected under the *Montana Water Quality Act*, Title 75, Chapter 5, Water Quality (MDEQ 2001) and Administrative Rules of Montana, Chapter 30, Water Quality, Sub-Chapter 6 (MDEQ 2002a). Under these regulations, Bighorn Lake is classified as a Class B1 water body. These waters are to be maintained suitable for:

- Drinking, culinary and food processing purposes (after conventional treatment);
- Bathing, swimming and recreation;
- Growth and propagation of salmonid fishes and associated aquatic life;
- Waterfowl and furbearers;
- Agricultural water supply; and
- Industrial water supply.

Anti-degradation Standards. Section 8 of Water Quality Rules and Regulations, Chapter 1 (WDEQ 2001a) provides regulations for anti-degradation policy applicable to waters in Wyoming. A similar non-degradation policy is found in Title 75, Chapter 5, Section 75-5-303 of the *Montana Water Quality Act* (MDEQ 2001). Both the Wyoming and Montana anti-degradation and non-degradation policies require that the level of water quality necessary to protect the beneficial uses defined in Classification of Waters listed above must be protected. Surface waters whose quality is better than standards must be maintained at that higher quality. Provisions may be made to allow exceptions when it can be demonstrated that allowing poorer water quality is necessary to accommodate important economic or social development in the area in which the waters are located (WDEQ 2001b and WDEQ 2001a).

Numeric Standards. The Wyoming Department of Environmental Quality (WDEQ) lists standards for priority pollutants applicable to waters in Wyoming according to the classification defined for the specific water body, which for Bighorn Lake is Class 2AB, in Appendix B of Wyoming Water Quality Rules and Regulations (WDEQ 2001a). Waters in Class 2AB are held to the "Fish and Drinking Water" standard for human health shown in table 6, which also shows the applicable standards for Class B1 waters in Montana found in Circular WQB-7, Montana Numeric Water Quality Standards (MDEQ 2001). Wyoming and Montana standards are provided for typical gasoline organic constituents such as benzo(a)pyrene, naphthalene, benzene, and MTBE.

The Wyoming standard for benzo(a)pyrene is less restrictive than the EPA human health criteria of 0.0038 µg/L (EPA 2002c). The Wyoming standard for benzene is more restrictive than the EPA human health criteria of 2.2 µg/L (EPA 2002c). The Montana human-health based standard for benzo(a)pyrene, and benzene are less restrictive than the EPA human health criteria (EPA 2002c). The Montana standard for naphthalene is less restrictive than the ecotoxicological benchmark standard of 62 µg/L (USFWS 1987). There is no EPA human health benchmark for MTBE, but the California Department of Health Services (2002) has established a primary maximum contaminant level (MCL) of 13 µg/L which is more restrictive than the Montana standard of 30 µg/L (CA DHS 2002).

WATER QUALITY DATA

Several water quality monitoring programs carried out from 1968 through 1971, 1975 and 1980 concluded that the Horseshoe Bend area of Bighorn Lake is highly eutrophic, with several blue-green algal blooms occurring during July and August. In contrast, eutrophication was not a problem near the Yellowtail Dam (Lee and Jones 1981). As mentioned above, phosphorus is the element most likely controlling algal growth within the reservoir in the summer months. The nitrate-nitrogen and ortho-phosphate concentrations are also high compared to most natural waters. The concentrations of nitrate-nitrogen and ortho-phosphate are higher at the southern end of the lake and can also contribute to algal blooms (NPS 1996b).

TABLE 6: WATER QUALITY STANDARDS FOR ORGANIC CHEMICALS

State*	Benzo(a)pyrene (µg/L)	Naphthalene (µg/L)	Benzene (µg/L)	MTBE
Montana	0.044	100	5	30
Wyoming	0.0044		1.2	

*Human Health based standards for Surface Water (Montana) and Fish and Drinking Water (Wyoming).

Source: MDEQ 2001, WDEQ 2001a.

Waters in Bighorn Lake have a high dissolved solids content in which calcium, sodium, sulfate and bicarbonate are the most common constituents found. Dissolved solids concentration and turbidity are higher at the upstream (south) end of the reservoir and are reduced as water moves through the reservoir to the north. The pH was found to be neutral to slightly alkaline and the water is moderately hard (NPS 1996b).

Studies at Bighorn Lake in 1992 focused on sampling sediments and water for polychlorinated biphenyl (PCB) and mercury. Concentrations in both water and sediments were found below detection levels of standard analysis techniques. However, the same study found moderately high mercury concentrations in walleye, while concentrations of PCBs were still below detection levels. The most likely source of mercury is believed to be from weathering of landforms, and erosion of soils from the drainage basin deposited in the reservoir (NPS 1996b).

MOTORCRAFT AFFECTING WATER QUALITY CONDITIONS

Motorized boating activity within Bighorn Lake includes fishing boats, inboard/outboard ski boats, and personal watercraft. Emissions from these watercraft contribute pollutants of concern to the waters of the reservoir. The quantity of pollutants contributed depends on the type and number of watercraft and the length of time operated within the reservoir.

The primary pollutants of concern that may be emitted from marine engines include methyl tertiary butyl ether (MTBE), polycyclic aromatic hydrocarbons (PAH), benzene, toluene, ethylbenzene and xylene (BTEX) and heavy metals such as copper. MTBE has been successful in reducing air pollution; however, it has been controversial from a water quality perspective. Although the use of MTBE is not banned in Montana, it is not deliberately added to gasoline sold in the state. MTBE can be found in low concentrations ranging from 2% to 3% by volume depending on the supplier. MTBE is not typically found in gasoline originating from refineries in Wyoming (Kuhn 2003).

AIR QUALITY

Bighorn Canyon National Recreation Area is in the sparsely populated Carbon and Big Horn Counties, Montana and Big Horn County, Wyoming. This part of Montana has a moderate climate considering its latitude. Snow seldom accumulates for extended periods of time because of the warm Chinook winds that blow from the mountains to the west (Crow Tribe 2003).

Bighorn Canyon National Recreation Area is subject to federal, State of Wyoming, and State of Montana air regulations. Federal or national ambient air quality standards (NAAQS) have been established by the Environmental Protection Agency. Current standards are set for sulfur dioxide (SO_2), carbon monoxide (CO), nitrogen dioxide (NO_2), ozone (O_3), particulate matter equal to or less than 10 microns in size (PM_{10}), fine particulate matter equal to or less than 2.5 microns in size ($PM_{2.5}$), and lead (Pb). These pollutants are collectively referred to as criteria pollutants.

The Planning, Prevention, and Assistance Division (PPAD) of the Montana Department of Environmental Quality (MDEQ) is responsible for monitoring and evaluating ambient air quality within the Montana segments of Bighorn National Recreation Area. Similarly, the Air Quality Division of the Wyoming Department of Environmental Quality (WDEQ) is responsible for regulating air quality in the Wyoming stretches of the reservoir. The MDEQ and WDEQ have adopted the federal national ambient air quality standards (NAAQS) presented in table 7, except where noted.

TABLE 7: NATIONAL, MONTANA, AND WYOMING AMBIENT AIR QUALITY STANDARDS

Pollutant	Averaging Time	NAAQS [a]		Montana [b]	Wyoming [c]
		Primary [d]	Secondary [e]	Concentration [f]	Concentration [f]
Ozone (O_3)[g]	8-Hour	0.08 ppm	Same as Primary Standard	—	0.08 ppm
	1-Hour	0.12 ppm (235 µg/m^3)		0.10 ppm	0.12 ppm (235 µg/m^3)
Carbon Monoxide (CO)	8-Hour	9.0 ppm (10 mg/m^3)	—	9 ppm	10 mg/m^3 (9 ppm)
	1-Hour	35 ppm (40 mg/m^3)		23 ppm	40 mg/m^3 (35 ppm)
Nitrogen Dioxide (NO_2)	Annual Average	0.053 ppm (100 µg/m^3)	Same as Primary Standard	0.05 ppm	0.05 ppm
	1-Hour	—	—	0.30 ppm	—
Sulfur Dioxide (SO_2)	Annual Average	0.03 ppm (80 µg/m^3)	—	0.02 ppm	60 µg/m^3 (0.02 ppm)
	24-Hour	0.14 ppm (365 µg/m^3)	—	0.10 ppm	260 µg/m^3 (0.10 ppm)
	3-Hour	—	1,300 µg/m^3 (0.5 ppm)	—	1300 µg/m^3 (0.5 ppm)
	1-Hour	—	—	0.50 ppm	—
Suspended Particulate Matter (PM_{10})	24-Hour	150 µg/m^3	Same as Primary Standard	150 µg/m^3	150 µg/m^3
	Annual Arithmetic Mean	50 µg/m^3		50 µg/m^3	50 µg/m^3
Fine Particulate Matter ($PM_{2.5}$)[f]	24-Hour	65 µg/m^3	Same as Primary Standard	—	65 µg/m^3
	Annual Arithmetic Mean	15 µg/m^3		—	15 µg/m^3
Lead (Pb)	Calendar Quarter	1.5 µg/m^3	Same as Primary Standard	—	1.5 µg/m^3
	90-Day Average	—	—	1.5 µg/m^3 [b] (rolling)	—
Visibility	No Federal standard			3 X 10^{-5}/m	—

mg/m^3 = milligrams per cubic meter; µg/m^3 = micrograms per cubic meter; ppm = parts per million; dash (--) indicates no standard.

Source: (EPA 2003b, MDEQ 2003b, WDEQ 2002).

a. National Ambient Air Quality Standards (other than O_3, particulate matter, and those based on annual averages or annual arithmetic mean) are not to be exceeded more than once a year.

b. Montana ambient air quality standards include standards for fluoride in forage, hydrogen sulfide, and settleable particulate. These standards are not relevant to this Environmental Assessment, and are not included in the table.

c. Wyoming ambient air quality standards include standards for fluoride, hydrogen sulfide, suspended sulfates, and odor. These standards are not relevant to this Environmental Assessment, and are not included in the table.

d. National Primary Standards: The levels of air quality necessary, with an adequate margin of safety, to protect the public health.

e. National Secondary Standards: The levels of air quality necessary to protect the public welfare from any known or anticipated adverse effects of a pollutant.

f. Concentration expressed first in units in which it was promulgated. Equivalent units given in parentheses are based upon a reference temperature of 25°C and a reference pressure of 760 millimeters (mm) of mercury. Most measurements of air quality are to be corrected to a reference temperature of 25°C and a reference pressure of 760 mm of mercury (1,013.2 millibar). Ppm in this table refers to ppm by volume or micromoles of pollutant per mole of gas.

g. New federal 8-hour ozone and fine particulate matter standards were promulgated by the Environmental Protection Agency on July 18, 1997. The federal 1-hour O_3 standard continues to apply in areas that violated the standard. Contact the Environmental Protection Agency for further clarification and current federal policies. (The federal standards for 8-hour ozone and $PM_{2.5}$ became effective on September 15, 1997, and were subsequently challenged and litigated. The U.S. Supreme Court affirmed the standards, and policies and systems to implement these new standards are being developed. No attainment classifications have been made for these pollutants. No new controls with respect to the new standards have been promulgated.)

Ambient air pollutant concentrations for the recreation area are believed to be within national and state air quality standards due to the relatively low population density near the national recreation area. The nearest CO, SO_2, PM_{10}, and $PM_{2.5}$ monitoring stations in Montana are located in Billings, Montana approximately 90 miles away from Bighorn Canyon National Recreation Area (MDEQ 2003a). The nearest PM_{10} monitoring station in Wyoming is located in Cody, approximately 50 miles away. The closest CO monitoring station to the national recreation area in Wyoming is located on the John D. Rockefeller Memorial Parkway at Flagg Ranch just south of the entrance to Yellowstone National Park, approximately 170 miles away.

Areas are classified under the Federal *Clean Air Act* as either "attainment" or "nonattainment" areas for each criteria pollutant based on whether the NAAQS have been achieved or not. When an area has been designated as an attainment area after having been nonattainment, it is also classified as a maintenance area. Bighorn Canyon is in an attainment area for all criteria pollutants; however, the nearby cities of Billings and Laurel, Montana are in nonattainment areas for CO and SO_2, respectively (EPA 2003d). Sheridan, Wyoming is a nonattainment area for PM_{10}. These cities are between 75 and 100 miles away.

Bighorn Canyon is designated a Class II Airshed. This designation was established by Congress to facilitate the implementation of air quality provisions of the *Clean Air Act*. This designation allows a moderate increase in certain air pollutants. The *Clean Air Act* requires that the National Park Service comply with all federal, state, and local air pollution control laws (*Clean Air Act*, Section 118).

The National Park Service maintains records of ozone levels measured as SUM06, which provide an indication of overall regional ozone exposure. The SUM06 data are based on the three-month highest measured values averaged over a five-year period and obtained during daylight hours. Data compiled by the National Park Service Air Resources Division show the SUM06 ozone index in the Bighorn Canyon area at 6–12 ppm-hours.

Visibility, as indicated by fine particulate matter less than 2.5 microns in aerodynamic diameter, ($PM_{2.5}$) in the area of Bighorn Canyon is generally good (EPA 2003c). Air-quality related values, scenic vistas, and pollution sensitive resources have not been identified.

SOUNDSCAPES

Soundscapes include both natural and human components. Natural soundscapes include all naturally occurring sounds such as waves on the shoreline or canyon walls, running water, birds calling, wind blowing through trees and canyons, or the sound of thunder. They also include "natural quiet" that occurs in the absence of natural or human caused sound. The opportunity to experience natural sounds is an enjoyable part of some visitors experience at Bighorn Canyon National Recreation Area.

Human-caused sounds at Bighorn Canyon National Recreation Area include all types of watercraft (including personal watercraft), automobiles, trucks, and electronic devices such as radios and horns. Human sounds are not unexpected or inappropriate at the recreation area, but are a part of the overall soundscape in an area where water activities, picnicking, camping, sightseeing, and other recreation use are part of the purpose of the national recreation area. Evaluation of the appropriateness of human sounds is evaluated by considering visitor expectation, management guidelines, resource sensitivity and park purpose.

NATURAL AND HUMAN NOISE LEVELS

Noise is generally defined as an unwanted or intrusive sound. Sounds are described as noise if they interfere with an activity or disturb the person hearing them. Sound is measured in a logarithmic unit called a decibel (dB). Since the human ear is more sensitive to middle and high frequency sounds than to low frequency sounds, sound levels are weighted to reflect human perceptions more closely. These "A-weighted" sounds are identified by the symbol dBA. Table 8 illustrates common sounds and the measured sound level.

For the average human a 10 dBA increase in the measured sound level is subjectively perceived as being twice as loud, and a 10 dBA decrease is perceived as half as loud. The decibel change at which the average human would indicate that the sound is just perceptibly louder or perceptibly quieter is 3 dBA. There is generally a 6 dBA reduction in sound level for each doubling of distance from a noise source due to spherical spreading loss (e.g., if the sound level at 25 feet from a PWC was 86 dBA, the sound level at 50 feet would be expected to be 80 dBA, at 100 feet 74 dBA).

Non-acoustical factors also play a role in how an individual responds to sounds. Non-acoustical factors vary from the past experience and adaptability of an individual to the predictability of when a noise will occur. The listener's activity will also affect how they responds to noise.

Personal watercraft and outboard motors are similar in the noise generated. The National Park Service contracted for noise measurements of personal watercraft and other motorized vessels in 2001 at Glen Canyon National Recreation Area (Harris et al. 2002). The results show that maximum personal watercraft noise levels at 25 meters (82 feet) ranged between 68 to 76 dBA. Noise levels for other motorboat types of similar horsepower as the personal watercraft measured during that study ranged from 65 to 77 dBA at 25 meters (82 feet).

TABLE 8: SOUND LEVEL COMPARISON CHART

Decibels	How it Feels	Equivalent Sounds
140–160	Near permanent damage level from short exposure	Large caliber rifles (e.g., .243, 30-06)
130–140	Pain to ears	.22 caliber weapon
100	Very loud Conversation stops	Air compressor at 20 feet; garbage trucks and city buses Power lawnmower; diesel truck at 25 feet
90	Intolerable for phone use	Steady flow of freeway traffic; 10 HP outboard motor; garbage disposal
80		Muffled Jet ski at 50 feet; automatic dishwasher; near drilling rig; vacuum cleaner
70		Drilling rig at 200 feet; window air conditioner outside at 2 feet
60	Quiet	Window air conditioner in room; normal conversation
50	Sleep interference	Quiet home in evening; drilling at 800 feet Bird calls
40		Library
30		Soft whisper
20		In a quiet house at midnight; leaves rustling
Note: Modified from NPS n.d. Final Environmental Impact Statement Miccosukee 3-1 Exploratory Well.		

Personal watercraft, unlike motorboats, are highly maneuverable, often resulting in quickly varying noise levels due to changes in acceleration and exposure of the jet exhaust when crossing waves. The frequent change in pitch and noise levels, especially if operated closer to land, make the noise from personal watercraft more noticeable to human ears (Asplund 2001).

PWC use at Bighorn Canyon is primarily focused in the wide stretches of the Bighorn Lake near Ok-A-Beh and Horseshoe Bend marinas, when there is adequate water for their use. The narrow winding canyons and unpredictable water levels create potentially dangerous PWC use conditions in other areas of the lake. The physical characteristics of the lake tend to increase, or amplify, sound levels, notably boating noise is reflected in areas where there are cliffs adjacent to the water. Noise sensitive activities that may occur throughout the lake include boat and shoreline fishing and wildlife watching. There are a number of areas within Bighorn Canyon that are closed to both PWC and motorboats. In these areas, it would be anticipated that there would be little or no watercraft noise. Noise related to PWC and other vessels, and sounds related to other human activity, are highest during the summer months due to inclement winter weather.

VISITOR RESPONSES TO PWC NOISE

Many factors affect how an individual responds to noise. Primary acoustical factors include the sound level, its frequency, and duration. Secondary acoustical factors include the spectral complexity, sound level fluctuations, frequency fluctuation, rise-time of the noise, and localization of the noise source (Mestre Greve Associates 1992).

Non-acoustical factors also play a role in how an individual responds to sounds. These factors vary from the past experience and adaptability of an individual to the predictability of when a noise will occur. The listener's activity also affects how they respond to noise. For example, users of PWC who are picnicking near the water edge and can hear the sounds of PWC, the sound may not be bothersome, but non-PWC users in the same location may be annoyed by the sound. During the months of June through August, it is estimated that 4 to 5 PWC use the lake during one day, or approximately 4% of the 82 watercraft at Bighorn Canyon National Recreation Area on a peak use day.

PWC generate noise that varies in pitch and frequency due to the nature of their construction and use. The two-stroke engines are often used at high speeds, and the craft bounce along the top of the water such that the motor discharges noise below and above the water surface. To recreation area visitors this irregular noise may seem to be more annoying that that of a standard motorboat that is cruising along the shoreline, even though the maximum noise levels may be similar for the two watercraft (approximately 80 dBA at 50 feet). Additionally, visitors who expect to experience natural quiet may consider the irregular noise of PWC more annoying, especially if the craft is operating in one location for extended periods of time. At Bighorn Canyon, most of the non-PWC watercraft do not operate at full throttle or high speed. This reflects both the limited areas for maneuvering as well as the primary water-based use, fishing. Therefore, the difference between the noise of PWC and that of other boats may be more pronounced. Park staff have not received formal noise complaints about personal watercraft.

The opportunity to experience the natural soundscape is part of the visitor experience. The national recreation area's natural soundscape contributes to a positive visitor experience and is a direct or indirect component of why many people visit the national recreation area.

WILDLIFE AND WILDLIFE HABITAT

Bighorn Canyon National Recreation Area is located within a semiarid region of Wyoming and Montana. Elevation variances and geographic formations, as well as differences in levels of precipitation, lead to a widely diverse landscape including riparian forests, upland prairies, deep canyons, mountains, broad valleys, streams, and Bighorn Lake. This diversity has allowed for the development of a variety of plant species and plant communities and provides habitat for a wide range of wildlife species. Utah juniper and curlleaf mountain mahogany are the most common vegetative species and dominate over 40% of the national recreation area.

The southern and more arid region of the national recreation area is a desert shrubland, which includes species such as greasewood, saltbush, curlleaf mountain-mahogany, and Utah juniper. The desert shrubland transitions into a juniper woodland midway through the national recreation area.

Higher elevations in the national recreation area begin north of the Great Basin area up to Bull Elk Basin in the north end of the national recreation area. This area contains the highest diversity of habitat, topography, and species of the national recreation area, including several rare wetland plants such as Hapeman's sullivantia. It is comprised of arid foothills grasslands, Utah juniper and curlleaf mahogany, and has limited coniferous forests of Douglas-fir, limber pine, Engelmann spruce, and subalpine fir.

The shortgrass prairie habitat is the smallest in the national recreation area, and is located in the northeast section of the national recreation area in the Fort Smith area. Vegetation in this area is mainly composed of sideoats grama, big bluestem, blazing star, and purple prairie-clover (Jacobs et al. 1996, Heidel and Fertig 2002).

From Yellowtail Dam south to Horseshoe Bend, Bighorn Lake is bordered by steep walls with minimal access for both human and animal visitors. South of Horseshoe Bend, Bighorn Lake opens up into the Yellowtail Wildlife Habitat area, which is managed by the Wyoming Game and Fish Department through agreements with the National Park Service, U.S. Bureau of Land Management (BLM), and U.S. Bureau of Reclamation (BOR). This area is characterized by large stands of cottonwood, riparian areas, shrubland, ponds, and wetlands, and is susceptible to water fluctuations due to reservoir operations and drought (NPS BICA Brochure). This area is managed as both a valuable habitat area for wildlife, including waterfowl, and as a recreational area for activities such as hunting, wildlife viewing, fishing, and camping.

These vegetation communities support a wide variety of wildlife, including 47 mammals, 212 birds, 6 amphibians, 14 reptiles, and 28 fish (Jacobs et al. 1996). There are also 739 confirmed species of plants within the national recreation area, and approximately 148 species which are likely present within the area boundaries (Heidel and Fertig 2002).

MAMMALS

Mule deer are common in the rugged topography of canyon and upland areas, and white-tailed deer are frequently seen within the Yellowtail Wildlife Habitat area. Beavers are common in streams and along floodplains. Yellow-bellied marmot, porcupine, striped skunk, badger, black bear, mountain lion, bobcat, mink, and muskrat are other fairly large mammals present in the national recreation area. Black bear and mountain lion are not numerous, but individuals are sighted several times each year (Jacobs et al. 1996).

Wild horses are not native, but have been present since their reintroduction by European settlers beginning in the late fifteenth century, and have had protected status on the Pryor Mountain Wild Horse

Range since 1968 (BLM webpage). One-third of the Pryor Mountain Wild Horse Range, which is managed by the BLM, is located within the national recreation area, though horses are not able to access Bighorn Lake due to the steep canyon walls except on the southern end of the reservoir near Horseshoe Bend.

BIRDS

The aquatic and riparian habitats of Bighorn Canyon are especially important to birds during spring and fall migrations. Of the 212 species of birds identified in the national recreation area, small songbird species constitute the majority. Other species include large raptors such as the bald eagle, large and small waterfowl (e.g., Canada goose, wood duck, and pintail), and shorebirds.

Small rookeries of great blue herons nest on the Yellowtail Wildlife Habitat area in mature cottonwood trees. Exact nesting locations, rookery sizes, and nesting activities are also well documented in the southern section of the national recreation area (Jacobs et al. 1996). Other birds, such as ducks and geese, also nest within this area. Canadian geese nest in the Dry Head Canyon area and on the shores of Afterbay Lake.

Introduced bird species include the ring-necked pheasant and Merriam and Rio Grande subspecies of wild turkey. Gray partridge and chuckar have migrated from other nearby locations of introduction. These introduced species, as well as native species such as Canada goose and a wide variety of ducks, are actively managed for sport hunting by the Wyoming Game and Fish Department in the Yellowtail Wildlife Habitat area (Jacobs et al. 1996). American white pelican, golden eagle, and a variety of songbirds are also present within the Wildlife Habitat area.

FISH

The fish community of the national recreation area consists of thirty fish species, approximately half introduced and half native species. The native fish community in both the reservoir and Bighorn and Shoshone Rivers includes sauger, channel catfish, several suckers, and many minnow species. Native fish within the tributaries of the Bighorn River include black bullhead, cutthroat trout, and flathead chub. Fish stocking of Bighorn Lake for recreational uses has occurred since the Yellowtail Dam was built. Stocked fish have included walleye, rainbow trout, lake trout, sockeye salmon, brown trout, spottail shiners, and white crappie. In recent years only walleye have been stocked.

Fish surveys were conducted by Redder et al. on 16 streams, in addition to the Bighorn River, in 1985. Only seven of those streams were found to contain fish. Fish caught included brook trout, brown trout, longnose sucker, longnose dace, and flathead chub. Surveys conducted by the staff of the Wyoming Game and Fish Department and the Montana Department of Fish, Wildlife and Parks have documented slightly more variety than detected in the 1986 survey (Jacobs et al. 1996).

AMPHIBIANS AND REPTILES

Five species of amphibians, all native to the area, are known to inhabit the national recreation area. These species are the blotched tiger salamander, the boreal chorus frog, the northern leopard frog, Woodhouse's toad, and the plains spadefoot toad. There has also been uncertain identification of the boreal (western) toad at a residence within the national recreation area. The plains spadefoot toad is classified as rare in the national recreation area, although regionally the species is common. Wetlands and riparian areas

associated with rivers and streams are the most important habitats in the national recreation area for amphibians (Jacobs et al. 1996).

AQUATIC INVERTEBRATES

Studies on aquatic invertebrates within Bighorn Lake are limited. Siltation, turbidity, and fluctuations in water levels likely limit any extensive development of aquatic invertebrates. A limited sampling of 10 sites in streams, ponds, and the reservoir was conducted in 1985, identifying macro-invertebrates to family or genus (Jacobs et al. 1996).

THREATENED, ENDANGERED, OR SPECIAL CONCERN SPECIES

WILDLIFE SPECIES

The U.S. Fish and Wildlife Service lists species as threatened or endangered when they are deemed to meet criteria detailed under the *Endangered Species Act of 1973*. In addition, candidate species are designated when there is adequate information regarding threats or vulnerability to warrant issuance of a proposed rule to list, but circumstances preclude rule issuance. Special concern species are those species for which listing may be warranted, but further research and study are needed.

Both Montana and Wyoming utilize a Species of Special Concern list in order to prioritize data collection and to provide information on the current status of these species. This list includes species that face particular threats, declining population trends, or restricted distribution that warrant special attention. The ranking system used by both states is a standardized system developed by The Nature Conservancy's Natural Heritage Network to assess the global and statewide conservation status of each plant and animal species, subspecies, and variety, and is detailed in table 9.

Wildlife species listed by the U.S. Fish and Wildlife Service as threatened or endangered or listed by the states of Montana or Wyoming as Species of Special Concern that may occur in or near the Bighorn Canyon National Recreation Area are listed in table 10.

TABLE 9: THE NATURE CONSERVANCY'S NATURAL HERITAGE NETWORK SPECIES OF SPECIAL CONCERN DEFINITIONS

Rank	Definition
S1	Critically imperiled because of extreme rarity or because of some factor(s) of its biology making it especially vulnerable to extinction
S2	Imperiled because of rarity or because of other factor(s) demonstrably making it very vulnerable to extinction throughout its range
S3	Either very rare and local throughout its range, or found locally (even abundantly at some of its locations) in a restricted range, or vulnerable to extinction throughout its range because of other factor(s).
S4	Apparently secure, though it may be quite rare in parts of its range, especially at the periphery.
S5	Demonstrably secure, although the species may be rare in parts of its range, especially at the periphery.

TABLE 10: FEDERAL AND STATE LISTED WILDLIFE IDENTIFIED IN THE VICINITY OF BIGHORN CANYON NATIONAL RECREATION AREA

Common Name	Scientific Name	Federal Status	State Status*	Habitat Present at Shoreline
BIRDS				
Bald eagle	*Haleaeetus leucocephalus*	T	S3 (MT); S2 (WY)	X
Mountain plover	*Charadrius montanus*	PT	S2	
American peregrine falcon	*Falco peregrinus anatum*	SC	S2 (MT); S1 (WY)	X
MAMMALS				
Rocky Mountain bighorn sheep	*Ovis canadensis canadensis*	SC	S4 (MT); S3 (WY)	X
Townsend's big-eared bat	*Corynorhinus townsendii*		S2 (MT); S1 (WY)	
AMPHIBIANS				
Northern leopard frog	*Rana pipiens*		S3	X
Plains spadefoot toad	*Spea bombifrons*		S4	
PLANTS				
Hapeman's sullivantia	*Sullivantia hapemanii* var. *hapemanii*		S2 (MT)	
Lesica's bladderpod	*Lesquerella lesicii*		S1 (MT)	
Persistent sepal yellowcress	*Rorippa calycina*		S1 (MT); S2S3 (WY)	X
Sweetwater milkvetch	*Astragalus aretiodes*		S2 (MT)	

Source: Nature Serve Explorer 2002.

SC: Species of Concern; T: Threatened; PT: Proposed Threatened.

*See table 9 for definition of state status.

FEDERAL SPECIES

The bald eagle, listed as threatened, winters in substantial numbers along the Bighorn River north of Yellowtail Dam (Jacobs et al. 1996). Some individuals nest along the Bighorn River south of the main reservoir, but the cottonwood trees in which the eagles nested were recently blown down and new nest sites have not been identified (Roney 2003).

The mountain plover is a proposed threatened species under the *Endangered Species Act*, and is currently listed in both Montana and Wyoming as an imperiled species. There has been no direct evidence of the presence of the mountain plover within the counties located in national recreation area boundaries, though the potential for occurrence exists (MT Natural Heritage Program website). Preferred habitat for the mountain plover consists of short-grass plains and fields, plowed fields, and sandy deserts (NatureServe Explorer 2002). It is not likely that the mountain plover occurs in the national recreation area.

The American peregrine falcon, whose federal status was recently changed from threatened to that of a species of concern, has been observed in Bighorn Canyon, has been documented as nesting near Devil Canyon overlook and possibly in the Dry Head Canyon area, and forages in a variety of habitats in the area (Jacobs et al. 1996).

Rocky Mountain bighorn sheep, which repatriated the area in the early 1970's, use the canyon walls for lambing and foraging throughout the summer. The national recreation area's herd numbers approximately 100-200 individuals and has the potential for partial dietary overlap with wild horses. Bighorn sheep are

frequently sighted in the very steep, rocky habitat along the Bad Pass Trail on the western edge of the national recreation area and lamb near the Devils Canyon Overlook area (Jacobs et al. 1996). They range from Crooked Creek Bay in Wyoming up to Dry Head Canyon in Montana (Roney 2003 and Stewart 2003).

STATE SPECIES

Seven species that may occur within the national recreation area, four of which are plant species, are listed on the Montana and Wyoming State Species of Special Concern lists and are not also federally protected (table 10). There is also one plant species that is listed as rare within the national recreation area by the National Park Service.

The Townsend's big-eared bat roosts in caves, abandoned mines, and buildings and also uses caves for maternity colonies and hibernacula. It is sensitive to human disturbance, and summer roosts and hibernacula are particularly vulnerable, leading to abandonment and increased mortality (Genter and Jurist 1995). Hibernacula, roosting, and maternity sites are located within an old building near Cemetery Pond in the Yellowtail Wildlife Habitat area (Roney 2003). It is not likely that the Townsend's big-eared bat occurs within areas of PWC use.

The northern leopard frog is typically found in riparian habitat near permanent water with rooted aquatic vegetation, such as springs, slow streams, marshes, bogs, ponds, canals, flood plains, reservoirs, and lakes (MT NHP). It is common within the national recreation area and likely occurs within areas of PWC use.

The plains spadefoot toad populates the grasslands of plains, hills, floodplains and deserts, as well as sagebrush and semidesert shrublands. The eggs and larvae develop in flooded areas and temporary pools formed by heavy rains and they sometimes breeds in permanent waters (NatureServe Explorer 2002). As previously mentioned, the plains spadefoot toad is common regionally, but classified as rare within the national recreation area. It is not likely that the plains spadefoot toad occurs in areas of PWC use.

Hapeman's sullivantia, also called Wyoming sullivantia or Hapeman's coolwort, is a wetland plant typically located along calcareous springs and seeps on moist canyon walls, streambank outcrops, and in close proximity to waterfalls at an elevation of 3,700 to 5,800 feet (MT NHP). It has been documented in Carbon and Big Horn Counties in Montana within the middle segment of the national recreation area along cold-water seeps and just upstream and downstream of the Yellowtail Dam (Heidel and Fertig 2002). Hapeman's sullivantia is not likely to occur in areas of PWC use.

Typical habitat for Lesica's bladderpod, also called Pryor Mountains bladderpod, is the gravelly, limestone derived soil of open ridges and slopes among Douglas fir and mountain mahogany woodlands at elevations of 5,300–7,600 feet (MT NHP). Though found in Carbon County, Montana within the national recreation area, Lesica's bladderpod is not likely to occur within areas of PWC use.

Persistent sepal yellowcress is found along moist banks of streams, stock ponds, and man-made reservoirs near the high-water line at 3,660–6,800 feet. The main threat to the species is alterations in water management that reduce the frequency of flooding. Other threats exist from competition with exotic plants, herbicide spraying, trampling by livestock, and recreational activities (Wyoming Natural Diversity Database). Persistent sepal yellowcress has been documented within the national recreation area on the mudflats at the south end of Yellowtail Reservoir (Heidel and Fertig 2002, Morstad 2003).

Sweetwater milkvetch, also called cushion milkvetch, is found on the thin, usually limestone derived soils of exposed ridges and slopes at elevations of 4,440–7,800 feet (MT NHP). Though found within the

national recreation area within Carbon County, Montana, sweetwater milkvetch is not likely to occur within areas of PWC use.

Rabbit buckwheat, also known as parasol wild buckwheat, is listed as a NPS rare plant within the national recreation area and is endemic to southern Montana and north-central Wyoming (Bighorn and Sheridan Canyons). Typical habitat for rabbit buckwheat is barren sandy or clay soils and rock outcrops in juniper woodlands and sagebrush steppe communities with an elevation of 3,800–5,500 feet (Fertig 1994). It has been documented within the national recreation area in Big Horn County, Wyoming and Carbon County, Montana. Rabbit buckwheat is not likely to occur within areas of PWC use.

SHORELINE VEGETATION

Due to water level fluctuations from reservoir operations as well as the steep-walled canyon that constitutes a majority of Bighorn Lake, substantial areas of shoreline vegetation are lacking. In a normal year, the shoreline is under water from mid-July to mid-September, and when exposed it consists mainly of gravel. In most areas, the closest vegetation is generally 30–50 feet above the water on canyon ledges.

NOXIOUS WEEDS

Thirteen plant species classified as noxious by Wyoming or Montana have been identified or reported within Bighorn Canyon and 105 exotic plants, 14.2% of the total flora, were documented in plant surveys conducted by Heidel and Fertig. Native plant communities within the national recreation area face threats from several of these species. Riparian areas and wetlands are most threatened by noxious weed invasion, especially those located at the southern end of the national recreation area in the Yellowtail Wildlife Habitat area. The continuing drought in the area has exposed extensive areas of mudflats, which are being colonized by both salt-cedar seedlings and Russian knapweed (Heidel and Fertig 2002).

VISITOR USE AND EXPERIENCE

Bighorn Canyon National Recreation Area is in a sparsely populated area of northern Wyoming and southern Montana. The cities nearest to the southern entrance to the national recreation area are Sheridan (103 miles), Buffalo (138 miles), Cheyenne (429 miles), Wyoming; and nearest to the northern entrance to the national recreation area are Billings (90 miles) and Helena (329 miles), Montana. The nearest large metropolitan areas are Salt Lake City Utah (499 Miles) and Denver, Colorado (526 miles). Most visitors to the recreation area come from the Bighorn Basin Region of Wyoming, and from the Laurel, Billings, Harden and Sheridan areas (a 75 to 100 mile radius). The recreation area is easily accessed via Interstate 90 from the north and travelers from the East and Midwest pass through the area en route to Yellowstone and Grand Teton National Parks (*Master Plan* 1971).

Approximately 243,000 visitors used the recreation area's facilities annually between 1995 and 2001. The peak use season is from Memorial Day to Labor Day, with fishing the predominant reason for visitation. PWC use occurs almost exclusively during the hot summer months with some minimal use in May and September.

ANNUAL VISITOR USE

Annual recreation visitor data for 1998 to 2001 is shown in table 11. Recent visitation has decreased from the level observed in 1998, but numbers have remained steady over the last four years (table 11).

Based on the data available, as well as discussions with park staff, no dramatic increase in park visitation is anticipated over the next 10 years. Population in surrounding counties is expected to increase by less than 1% per year between 2002 and 2012.

MONTHLY VISITOR USE

While the national recreation area is open year-round, over half of the visits occur in June, July, August, and September (NPS 2002b). Based on monthly visitor statistics, an average of 1,133 people visited the recreation area each day in June, July, August and September (NPS 2002b).

VISITOR ACTIVITIES

Fishing is the predominant activity associated with boating on Bighorn Lake, but water skiing, PWC use, and swimming also occur. Sailing, canoeing, kayaking and drift boating occur infrequently on the lake, due to the physical characteristics of the lake. The use of drift boats is primarily confined to the north end of Bighorn Lake. Other summer activities include, sightseeing, photography, wildlife watching, hiking, backpacking, camping, and picnicking.

Estimated water related activities during the past three seasons derived from traffic counters and NPS staff observations are listed below in table 12.

TABLE 11: AVERAGE ANNUAL VISITATION AT BIGHORN CANYON, 1995-2001

Year	Number of Recreation Visitors	Percentage Change from Previous Year
1998	279,637	47%
1999	234,013	-16%
2000	238,049	-1.7%
2001	241,388	-1.4%

Source: NPS 2002b.

TABLE 12: WATER RECREATION USE STATISTICS AT BIGHORN CANYON

Season	Shore Fishermen	Swimmers	Boaters	Personal Watercraft
2000	1,793	5,695	3,526	Not available
2001	1,498	3,845	9,606	449
2002	1,519	Not available	1,428	103

Source: Bighorn Canyon National Recreation Area staff estimations.

Camping

There are five lakeshore campgrounds within the recreation area; two of which have boat-in access only. Camping is allowed in the backcountry and below the highwater mark along Bighorn Lake. Horseshoe Bend in the south is the largest campground with 128 sites for RVs or tent campers. Trail Creek Campground at Barry's Landing has five tent-only sites and seven sites suitable for trailers or tents. Medicine Creek, a boat-in or hike-in only campground, is located north of Barry's Landing in Medicine Creek and has eight tent sites. Black Canyon Campground is a boat-in only campground (but has no boat ramp) and is located 5 miles south of Ok-A-Beh Marina. This site contains 17 tent sites, but winter and spring low water levels can make access to the campground difficult. Afterbay Campground is adjacent to Afterbay Lake, contains 29 sites, which accommodate both RVs and tents year round (backpacker.com). Since all of the campgrounds are boat accessible, depending on water levels, there can be some boating activity near these camping areas (NPS BICA brochure). In examining the overnight monthly statistics, it appears that camping has not been affected by the 2001–2002 drought. Boat-in campgrounds are in the north and have been accessible during the drought season.

From 1997 through 2001, recorded overnight stays in the recreation area averaged 14,256 overnight stays per year, with 66% of the stays RV campers, 30% tent campers, and 4% backcountry campers. (NPS 2002b)

Fishing

Fishing is one of the primary activities at Bighorn Canyon. The Afterbay Lake below the Yellowtail Dam is a good spot for trout fishing, and the Bighorn River below the Afterbay Dam is a world class brown and rainbow trout fishing area. The most popular game fish in Bighorn Lake is walleye, though other game fish, including brown and rainbow trout, sauger, ling, and perch abound in Bighorn Lake. Winter ice fishing occurs around Horseshoe Bend (NPS BICA brochure).

Hiking/Backpacking/Wilderness Experience

Bighorn Canyon National Recreation Area offers opportunities for solitude, serenity, and beauty (NPS website). Hiking is available in the recreation area, with more hiking opportunities in the southern end of the recreation area than the northern end. The Barry's Island Loop/Medicine Creek Loop trail is three miles long, and offers another 1.8-mile long spur trail on the way. The Barry's Landing trail is surrounded by an oxbow in the river that is slowly carving its way through the land (Outdoorplaces.com 2003). The spur trail leads to the Medicine Creek backcountry campsite, the only improved backcountry site in the national recreation area accessible by land. The scenery of the canyon is incredible and the campground offers solitude at almost any time of the year (Outdoorplaces.com 2003).

Additional short hiking trails can be found off Wyoming state road 37 near Layout Creek just south of Barry's Landing (Outdoorplaces.com 2003).

Shoreline Use

Except at campgrounds and boat launch areas, there is no road access to the shoreline of Bighorn Lake; however, the entire shoreline is open for use. Popular day-use areas are Horseshoe Bend, Barry's Landing, and Ok-A-Beh. Activities include fishing, picnicking, swimming, and some boating and PWC use.

Swimming

Swimming is allowed throughout the lake; however, swimmers are encouraged to use the lifeguard areas at Horseshoe Bend and Ok-A-Beh (NPS BICA brochure).

Concessions

There are two marinas operated by concession, at Horseshoe Bend and Ok-A-Beh. Services include limited food concessions, showers, groceries, fishing supplies, boat rental, gas sales, and canyon cruises. (custermt.com)

Watercraft were available for rent from the concessioner at the Horseshoe Bend Marina in 1999 and 2000. The Marina did not open in 2001 or 2002 due to continuing drought conditions and the resulting lack of water in the Horseshoe Bend area. It is not known if PWC rentals will resume in the Horseshoe Bend area should water levels return to a normal condition. The concessionaire at Ok-A-Beh has not rented personal watercraft in the past and currently has no intention of renting them in the future. When personal watercraft are unavailable for rent in the national recreation area, the closest rental opportunity is at least 100-miles away. Personal watercraft are available for sale in Billings, Montana some 90 miles from either end of the national recreation area.

General Watercraft Use (Motorboats, Canoes, and Kayaks)

Motorboat and other watercraft use at Bighorn Canyon National Recreation Area has occurred since 1968, with PWC use first noticed in the 1990s. Fishing and recreational boating are the main boating activities. Watercraft are piloted over the main surface of the lake, along the lakeshore, and in coves and back bays.

Bighorn Canyon has two marinas: Horseshoe Bend and Ok-A-Beh. Both provide gas, rental docks, food, and boater supplies, typically from Memorial Day through Labor Day. Watercraft can also enter the lake at Barry's Landing, which has a launching ramp but no marina. Primitive access to the lake is available at the causeway, and access to the Bighorn and Shoshone Rivers is available throughout the Yellowtail Wildlife Habitat. Above the dam, boats may be launched at the Afterbay launch ramp, and on the river at the Afterbay and Three-Mile access areas.

Based on current data available, approximately 9,600 boats and 459 PWC use Bighorn Lake each year (see the "PWC and Boating Use Trends" section). All motorboats, including personal watercraft, are required to purchase permits. During the peak month of July, up to 77 boats and 5 PWC may use the reservoir per day.

Kayakers, canoeists, and sailors also visit the recreation area, but make up a small percentage of lake users due to the lack of winds in the north unit and the lake's characteristics (limited landing opportunities). Over the last four years, the national recreation area staff have observed approximately five canoeists, kayakers, and drift boaters in the Ok-A-Beh area of the lake (based on park staff estimations). When lake levels were higher, the lake area south of the South Narrows was a popular spot for sailing where locals take advantage of the relentless prairie winds (Outdoorplaces.com 2003).

PWC Use

Personal watercraft use on Bighorn Lake began during the early 1990s. During 2001, personal watercraft comprised approximately 4% of the boat use on Bighorn Lake. Prior to closure personal watercraft operated throughout the national recreation area, but due to the narrowness of Bighorn Lake, most personal watercraft use occurred at the north end of the reservoir in the vicinity of Ok-A-Beh Marina or in the several wide sections of the lake. Minimal PWC activity occurred in the Yellowtail Wildlife Habitat area. When there is water at the Horseshoe Bend camping/launch area, there is some PWC use in the area, however users tend to stay south of Devil Canyon. When there is less water in the south, users move north, and then some PWC use can be found at Barry's Landing. PWC use at this facility does not extend very far from the landing itself.

PWC have been observed traversing back and forth across the lake, cruising and sometimes racing along the shoreline, exploring the rock cliffs up close, jumping wakes of other boats, traveling to beach destinations. Some thrill-seeking activity by personal watercraft users did occur. PWC use occurred primarily during June, July, and August and September, with July having peak use. Most personal watercraft likely operate between the hours of dawn to dusk, with the average PWC trip within Bighorn Canyon National Recreation Area lasting about two hours.

Bighorn Canyon is the primary destination for PWC use in the area, although there are several locations within 200 miles that permit PWC use. In Wyoming, these include: Buffalo Bill Reservoir (52 miles); Boysen Reservoir (123 miles); Ocean Lake (180 miles); and Pilot Butte Dam (183 miles). Alternate locations for PWC use in Montana include: the Tongue River Reservoir (90 miles) and Cooney Reservoir (150 miles).

VISITOR SATISFACTION

Generally, there is very little information specific to PWC use and visitor concerns. Information gathered from a Visitor Survey Card in 1998 reflected that 93% of visitors were satisfied with their experience.

VISITOR CONFLICT AND VISITOR SAFETY

Prior to the November 2002 closure to personal watercraft, the use of PWC within the Bighorn Canyon National Recreation Area was authorized, except in areas restricting vessels, which include personal watercraft. Operators of personal watercraft were subject to all applicable Federal and state laws. Montana and Wyoming State boating laws also applied to PWC operators at the national recreation area. Both states define personal watercraft as boats or watercraft when addressing safe operations, the registering and numbering of vessels, and noise limitations. The following state of Wyoming and Montana regulations apply in the portion of the recreation area residing within the respective state:

Montana:

- A person 15 years of age and older may operate any craft. Children 12 years and younger must have someone 18 years or older to operate a craft over 10 horse power. Children 13–14 must have a motorboat operators' certificate or have an 18 year old present to operate a craft over 10 horse power.

- All craft must have a personal flotation device for everyone aboard. All children 12 and under must wear a PFD.

- All craft must remain: 20 feet from swim area; 75 feet from a person hunting or fishing; 200 feet from a person in the water.

- PWC must remain no-wake within 200 feet of a dock, swimmer, swimming raft, non-motorized boat or anchored vessel on a lake or river.

- All motorized watercraft must remain more than 100 yards from vessel or skier while crossing a wake.

- Water skiers must remain 50 feet from swimmer or swim area.

- Motor noise must not exceed 86 decibels at 50 feet or 90 dbl at 1 meter [39.37 inches].

Wyoming:

- Minimum operator age is 16 for all motorboats.

- No person shall operate a motorized watercraft at a speed, which causes a wake within one-hundred (100) feet of a drifting, trolling or anchored watercraft or person(s) in the water.

- No person operating a personal watercraft shall cross or jump the wake of another watercraft when within 100 feet of the watercraft creating the wake.

- No person shall operate a personal watercraft unless the watercraft is equipped by the manufacturer with a "kill switch". The kill switch shall be attached via a lanyard to the operator of the personal watercraft when it is underway in such a manner that in the event the operator is ejected from the personal watercraft the engine shall stop.

- No person shall operate a motorized watercraft at a speed, which causes a wake within 100 feet of a drifting, trolling or anchored watercraft or person(s) in the water.

- All PWC operators and passengers are required to wear PFDs. Federal law effective December 23, 2002 requires all children under 13 must wear a properly fitting PFD while underway

- There are currently no state regulations regarding hours of operation in either Montana or Wyoming.

PWC-RELATED VIOLATIONS AND CONFLICTS WITH OTHER VISITORS

Many of the activities undertaken by visitors to Bighorn Canyon National Recreation Area are compatible. For example, swimming, canoeing, fishing, and picnicking can occur together and produce little or no conflict between visitors. However, boating near swimmers, fishermen, and non-motorized vessels can pose a safety conflict for both parties, and as discussed under "Soundscapes," noise generated by personal watercraft can also affect visitor experiences.

Since PWC constitute a small percentage of overall boating use within Bighorn Canyon National Recreation Area accidents involving personal watercraft have been minimal. There were two PWC accidents in 2000 and none in 2001 and 2002. Both accidents in 2000 were due to the operators' inexperience with personal watercraft, allowing it to run into other vessels. Statistics for other vessel accidents per year are similar.

Although personal watercraft can reach speeds in the 60-mph range, most do not do so at Bighorn Canyon National Recreation Area due to the lake's configuration (lack of long stretches). There are few access points to shallow-draft areas, which can create wakes that pose a conflict and safety hazard to other users, such as canoeists and kayakers. Of bigger concern to other boaters and visitor safety are personal watercraft users approaching boats too close and jumping other boat wakes. Bighorn Canyon National Recreation Area has issued citations under Montana and Wyoming state law to personal watercraft users for acts such as wake jumping, under-age riding, and failing to wear floatation devices. The most common citation has been for under-age riding.

Complaints regarding misuse of personal watercraft have been received infrequently, and the most commonly reported are wakes in the flat-wake zones near boat launch areas. Bighorn Canyon National Recreation Area has received no written complaints regarding PWC use.

CULTURAL RESOURCES

HISTORICAL BACKGROUND

The Bighorn Basin has witnessed over 14,000 years of continuous human habitation. The earliest inhabitants moved throughout the region in response to changing seasons and variations in available plants and animals. Artifacts associated with the Kootenai suggest prehistoric settlement of that group west of the Continental Divide. The Salish, the Pend d'Oreilles, and the Crow were likely among the first Native Americans to follow the Kootenai. The last tribes to arrive in this region were the Chippewa and Cree in the late 19th century. Also during the 19th century, trappers, and traders arrived. In 1879 the first arrival of cattle led to the development of ranches scattered in and close to the national recreation area (NPS 2001c, Montana Southern Baptist Convention 2003).

ARCHEOLOGICAL RESOURCES

In 1999, the National Park Service listed 186 archeological sites inventoried, evaluated, listed, and entered on the Archeological Sites Management Information System (ASMIS). Archeological sites or features, within the park listed on the National Register of Historic Places include Bad Pass Trail (east of Warren along the Big Horn River), Cedarvale (present town of Hillsboro and its environs), Pretty Creek Archeological Site and Bighorn Ditch Headgate (west of Fort Smith at the mouth of the Bighorn Canyon) (NPS NRIS). None of these four sites or features are within the areas of existing or potential future landing or PWC use areas. No new archeological surveys or investigations have been undertaken in conjunction with this study to examine areas of existing or potential future landing areas.

SUBMERGED CULTURAL RESOURCES

Prior to construction of the dams, archeological sites were acknowledged to occur within the path of the reservoir. No specific surveys have been conducted to record submerged resources. Given the water depths of the Bighorn Canyon, no specific concerns have been expressed. While recent drought conditions have resulted in record low-water levels, no concerns have been expressed regarding submerged resources.

SOCIOECONOMIC ENVIRONMENT

A detailed description of the socioeconomic environment affected by PWC at Bighorn Canyon National Recreation Area is provided in the report "Economic Analysis of Personal Watercraft Regulations in Bighorn Canyon National Recreation Area" (LAW et al. 2002). The following is a brief summary of relevant sections.

Typical PWC use at Bighorn Canyon is by families traveling less than 100 miles. According to park staff observations, the majority of PWC users at Bighorn Canyon bring their own PWC. There are three businesses within a 100-mile radius of the national recreation area that sell PWC, however, none that rent.

Bighorn Canyon reportedly is the primary destination for PWC use in the area, although there are several locations within 200 miles of the national recreation area that permit PWC use. In Wyoming these include: Buffalo Bill Reservoir (Cody); Boysen Reservoir (Thermopolis); Ocean Lake (Riverton); and Pilot Butte Dam. Alternative locations for PWC use in Montana include the Tongue River Reservoir (Decker) and Cooney Reservoir (Columbus).

Bighorn Canyon is located in a remote area where agriculture, mining, and tourism are the largest industries. Billings is the largest town in the region, but the following small towns area all within 75 files of the national recreation area: Fort Smith, Frannie, Deaver, Lovell, Byron, and Powell (all in Wyoming); and Fort Smith, Montana.

NATIONAL RECREATION AREA MANAGEMENT AND OPERATIONS

There are three full-time protection rangers and three seasonal protection rangers dedicated to enforce all regulations throughout Bighorn Canyon National Recreation Area. Daily boat patrols do not occur, with emphasis being placed on periods of higher motorcraft use, such as summer holiday weekends and regular weekends. During this period, one to two rangers throughout the day may be on the lake patrolling from one to three hours.

ENVIRONMENTAL CONSEQUENCES

SUMMARY OF LAWS AND POLICIES

Three overarching environmental protection laws and policies guide the National Park Service: the *National Environmental Policy Act* (NEPA) of 1969, and its implementing regulations; the *National Parks Omnibus Management Act of 1998* (NPOMA); and the NPS *Organic Act of 1916*.

1. The *National Environmental Policy Act* is implemented through regulations of the Council on Environmental Quality (CEQ) (40 CFR 1500–1508). The National Park Service has in turn adopted procedures to comply with the act and the CEQ regulations, as found in *Director's Order #12: Conservation Planning, Environmental Impact Analysis, and Decision-making* (NPS 2001a), and its accompanying handbook.

2. The *National Parks Omnibus Management Act of 1998* (NPOMA) (16 USC 5901 et seq.) underscores the *National Environmental Policy Act* in that both are fundamental to NPS park management decisions. Both acts provide direction for articulating and connecting the ultimate resource management decision to the analysis of impacts, using appropriate technical and scientific information. Both also recognize that such data may not be readily available, and they provide options for resource impact analysis should this be the case.

3. The *Omnibus Act* directs the National Park Service to obtain scientific and technical information for analysis. The NPS handbook for *Director's Order #12* states that if "such information cannot be obtained due to excessive cost or technical impossibility, the proposed alternative for decision will be modified to eliminate the action causing the unknown or uncertain impact or other alternatives will be selected" (sec. 4.4).

4. Section 4.5 of *Director's Order #12* adds to this guidance by stating "when it is not possible to modify alternatives to eliminate an activity with unknown or uncertain potential impacts, and such information is essential to making a well-reasoned decision, the National Park Service will follow the provisions of the regulations of CEQ" (40 CFR 1502.22). In summary, the Park Service must state in an environmental assessment or impact statement (1) whether such information is incomplete or unavailable; (2) the relevance of the incomplete or unavailable information to evaluating reasonably foreseeable significant adverse impacts on the human environment; (3) a summary of existing credible scientific adverse impacts that is relevant to evaluating the reasonably foreseeable significant adverse impacts; and (4) an evaluation of such impacts based on theoretical approaches or research methods generally accepted in the scientific community.

5. The 1916 NPS *Organic Act* (16 USC 1) commits the Park Service to making informed decisions that perpetuate the conservation and protection of park resources unimpaired for the benefit and enjoyment of future generations.

In July 2002, the Environmental Protection Agency proposed new evaporative emissions standards for gasoline-fueled boats and personal watercraft. These proposed standards would require most new boats produced in 2008 or later to be equipped with low-emission fuel tanks or other evaporative emission controls.

GENERAL METHODOLOGY FOR ASSESSING IMPACTS

While much has been observed and documented about the overall effects of personal watercraft on the environment, as well as public safety concerns, site-specific impacts under all conditions and scenarios are difficult to measure and affirm with absolute confidence. Since personal watercraft were introduced in parks, data collected and interpreted about them and their effects on park resources relative to other uses and influences are difficult to define and quantitatively measure, despite monitoring.

Recognizing this dilemma, the interdisciplinary planning team created a process for impact assessment, based upon the directives of the *DO #12 Handbook* (NPS 2001a, sec. 4.5(g)). National park system units are directed to assess the extent of impacts on park resources as defined by the context, duration, and intensity of the effect. While measurement by quantitative means is useful, it is even more crucial for the public and decision-makers to understand the implications of those impacts in the short and long term, cumulatively, and within context, based on an understanding and interpretation by resource professionals and specialists. With interpretation, one can ascertain whether a certain impact intensity to a park resource is "minor" compared to "major" and what criteria were used to base that conclusion.

To determine impacts, methodologies were identified to measure the change in park resources that would occur with the implementation of the PWC management alternatives. Thresholds were established for each impact topic to help understand the severity and magnitude of changes in resource conditions, both adverse and beneficial, of the various management alternatives.

Potential impacts are described in terms of type (Are the effects beneficial or adverse?); context (Are the effects site-specific, local, or even regional?); duration (Are the effects short-term, lasting less than one year, or long-term, lasting more than one year?); and intensity (Are the effects negligible, minor, moderate, or major?). Because definitions of intensity (negligible, minor, moderate, or major) vary by impact topic, intensity definitions are provided separately for each impact topic analyzed in this document.

Each alternative is compared to a baseline to determine the context, duration, and intensity of resource impacts. For purposes of impact analysis, the baseline is the reinstatement of personal watercraft use and current management projected over the next 10 years (alternative A). In the absence of quantitative data, best professional judgment was used to determine impacts. In general, the thresholds used come from existing literature on personal watercraft, federal and state standards, and consultation with subject matter experts and appropriate agencies.

In addition to establishing impact thresholds, the national recreation area's resource management objectives and goals (as stated in the "Purpose of and Need for Action" chapter) were integrated into the impact analysis. In order to further define resource protection goals relative to personal watercraft management, the national recreation area's *Strategic Plan* (NPS 2001c) was used to ascertain the "desired future condition" of resources over the long term. The impact analysis then considers whether each management alternative contributes substantially to the national recreation area's achievement of its resource goals, or would be an obstacle. The planning team then considered potential ways to mitigate effects of personal watercraft on park resources, and the alternatives were modified accordingly.

For the purposes of analysis, the following assumptions are used for all impact topics:

> *Short-term impacts*: Those impacts occurring from PWC use in the immediate future (per trip through a single season of use, usually 1 to 6 months).

Long-term impacts: Those impacts occurring from PWC use over several seasons of use through the next 10 years.

Direct impacts: Those impacts occurring from the direct use or influence of PWC use.

Indirect impacts: Those impacts occurring from PWC use that indirectly alter a resource or condition.

Impact Analysis Area: Each resource impact is assessed in direct relationship to those resources affected both inside and outside the national recreation area, to the extent that the impacts can be substantially traced, linked, or connected to PWC use inside park boundaries. Each impact topic, therefore, has an impact analysis area relative to the resource being assessed, and it is further defined in the impact methodology.

CUMULATIVE IMPACTS

The CEQ regulations to implement the *National Environmental Policy Act* require the assessment of cumulative impacts in the decision-making process for federal projects. Cumulative impacts are defined as "the impact on the environment which results from the incremental impact of the action when added to other past, present, and reasonably foreseeable future actions regardless of what agency (federal or non-federal) or person undertakes such other actions" (40 CFR 1508.7). Cumulative impacts are considered for all alternatives, including the no-action alternative.

Cumulative impacts were determined by combining the impacts of the alternative being considered with other past, present, and reasonably foreseeable future actions. Therefore, it was necessary to identify other ongoing or reasonably foreseeable future projects at Bighorn Canyon and, if applicable, the surrounding region, as discussed in the "Purpose of and Need for Action" chapter.

IMPAIRMENT ANALYSIS

The NPS *Management Policies* (NPS 2000c) require an analysis of potential effects to determine whether or not actions would impair park resources. The fundamental purpose of the national park system, as established by the *Organic Act* and reaffirmed by the *General Authorities Act*, as amended, begins with a mandate to conserve park resources and values. NPS managers must always seek ways to avoid, or to minimize to the greatest degree practicable, adversely impacting park resources and values. However, the laws do give the National Park Service the management discretion to allow impacts to park resources and values when necessary and appropriate to fulfill the purposes of a park, as long as the impact does not constitute impairment of the affected resources and values. Although Congress has given the National Park Service the management discretion to allow certain impacts within a park system unit, that discretion is limited by the statutory requirement that the agency must leave park resources and values unimpaired, unless a particular law directly and specifically provides otherwise. The prohibited impairment is an impact that, in the professional judgment of the responsible NPS manager, would harm the integrity of park resources or values. An impact to any park resource or value may constitute an impairment, but an impact would be more likely to constitute an impairment to the extent that it has a major or severe adverse effect upon a resource or value whose conservation is:

- necessary to fulfill specific purposes identified in the establishing legislation or proclamation of the national recreation area;

- key to the natural or cultural integrity of the park; or

- identified as a goal in the park's general management plan or other relevant NPS planning documents.

Impairment may result from NPS activities in managing the park, visitor activities, or activities undertaken by concessioners, contractors, and others operating in the park.

The following process was used to determine whether the various PWC management alternatives had the potential to impair park resources and values:

1. The park's enabling legislation, the *Master Plan* (NPS 1971), the *Strategic Plan* (NPS 2001c), and other relevant background were reviewed with regard to the unit's purpose and significance, resource values, and resource management goals or desired future conditions. There are no substantive changes to population, land use, or park management anticipated within the next 10 years.
2. PWC management objectives specific to resource protection goals at the park were identified.
3. Thresholds were established for each resource of concern to determine the context, intensity and duration of impacts, as defined above.
4. An analysis was conducted to determine if the magnitude of impact reached the level of "impairment," as defined in NPS *Management Policies* (NPS 2000c).

The impact analysis includes any findings of impairment to park resources and values for each of the management alternatives.

PWC AND BOATING USE TRENDS

CURRENT USE ESTIMATES

PWC use trends were identified to determine direct and indirect impacts of PWC management strategies on park resources. Because boating and related water activities are primary visitor use activities at Bighorn Canyon, boating use trends were researched to help assess cumulative effects.

Current and future use estimates were determined for the north and south ends of the reservoir based on boat and PWC counts during the 2001 summer season. In 2001, 449 PWC and 9,606 boats were counted. These numbers were distributed over a 4-month season from June through September for PWC and over a 6-month season from May through October for boats as shown in table 13. This distribution was based on the estimated use season provided by park staff and Bighorn Canyon recreation use statistics maintained by the National Park Service Statistics Office (NPS 2002b).

Data was also available for the 2002 summer season. However, because of the recent drought, boat ramps were only open for a very limited period (varied between 2 to 6 weeks depending upon location) and did not represent an average year's PWC or boating use. Approximately 1,081 boats and 79 PWC were estimated on the south end of the reservoir (Barry's Landing) between June 6th and July 21st (6 weeks). On the northern end of the reservoir (Ok-A-Beh), 347 boats and 24 PWC were counted between June 28th and July 8th. When the 2002 numbers are extrapolated from the observed use during the 2 to 6 week summer season in 2002 to the 4-month season that occurs during normal years, the PWC numbers are almost identical between 2001 and 2002. Therefore, reliance on the 2001 PWC and boating numbers was assumed to be reasonable.

TABLE 13: DAILY AND ANNUAL WATERCRAFT USE AT BIGHORN CANYON NATIONAL RECREATION AREA

Visitor Use Season	Days per year	Total Boats/day	Total Boats/year	Total PWC/day	Total PWC/year
Peak month (July)	31	77	2,387	5	155
Medium use (June and August)	61	61	3,721	4	244
Low use days (May & Sept for boats; Sept for PWC)	61 (boats) 30 (PWC)	45	2,745	2	60
Shoulder season (Oct)	31	26	806	0	0
TOTAL	NA	NA	9,659*	NA	459*

Source: National Park Service counts and observations for 2001 and 2002; PWC and boating use was distributed according to Bighorn Canyon recreation use statistics by month (NPS 2002b).

*Totals are estimated, not exact.

NA = not applicable.

FUTURE USE TRENDS

Future PWC and boating estimates for Bighorn Canyon were determined by evaluating national and some limited state PWC use trends, state boating registrations for Montana and Wyoming, and population projections for Montana and Wyoming. These trends were also compared to recreation visits at Bighorn Canyon over the past decade to determine if population growth relates to visitation.

PWC and Boating Trends. It is assumed that by 2001 or 2002 PWC registrations in both Montana and Wyoming were most likely increasing only slightly each year or may have begun to decline similar to national PWC use and registration trends (see "Summary of National Research on the Effects of Personal Watercraft" section in the "Purpose of and Need for Action" chapter). Boater registrations show similar trends in Montana and Wyoming. In Montana, boating registrations have increased approximately 1.7% each year since 1996 (table 14). Wyoming registrations show similar trends from 1997 to 2000. PWC use data was only available (through U.S. Coast Guard statistics) for several years in the state of Wyoming. Between 1997 and 2000, PWC registrations were increasing annually, but at a decreasing rate (table 15).

Population and Visitation Trends. Bighorn Canyon National Recreation is surrounded by Big Horn County in both Wyoming and Montana. Most of the recreation use at the reservoir is from these counties and other nearby Montana and Wyoming counties that exhibit similar population trends. Population in Big Horn County, Wyoming is predicted to increase by 3% between 2002 and 2010, a 0.375% annual increase. The state of Wyoming population is projected to increase by a similar 0.5% annually (www.eadiv.state.wy.us/pop). Population in Big Horn County, Montana is estimated to increase by 8% between 2002 and 2015, a 0.83% annual increase. Montana state population is predicted to increase by approximately 1% annually (Montana Department of Commerce 2003)

Bighorn Canyon visitation has fluctuated from a high of 481,098 recreation visits in 1991 to a low of 190,509 recreation visits in 1997. Between 1998 and 2001 recreation visits have varied in a small range between 234,013 and 279,637. Thus, overall recreation visits have decreased over the past decade, but in the last four years have remained relatively steady. Lack of water in the reservoir over the past several years has influenced visitation and is expected to continue to influence visitation over the next several years due to reservoir closures. Drought conditions will most likely influence visitation to a greater degree than population trends.

TABLE 14: MONTANA BOAT REGISTRATIONS

Year	Total Boats	Annual % Change - Boats
1994	42,084	
1995	45,650	8.5
1996	46,474	1.8
1997	47,102	1.4
1998	49,336	4.7
1999	50,687	2.7
2000	51,325	1.3

Source: USCG n.d.

PWC are not counted separately in Montana; included in boat totals.

TABLE 15: WYOMING BOAT AND PWC REGISTRATIONS

Year	Total Boats*	Annual Percentage Change - Boats	Personal Watercraft	Annual Percentage Change - PWC
1994	27,269			
1995	26,014	- 4.6		
1996	24,081	-7.5		
1997	25,304	5.0	1,832	
1998	25,828	2.0	2,020	10
1999	26,287	1.7	2,194	8.6
2000	26,926	2.4	2,288	4.2

Source: USCG n.d.

* All powerboats, sailboats, canoes, kayaks, and personal watercraft are included in total, although counted separately.

PWC and Boating Growth Rates. Based on the previous population and PWC/boating registration information, a 1% annual growth rate in PWC and boating use at Bighorn Canyon National Recreation Area was assumed between 2002 and 2012. Given the current drought conditions, the anticipated reservoir closure to all boating use in 2003, and the limited population growth in surrounding counties, PWC and boating growth rates could actually be 0 or possibly negative. However, because water levels and other future conditions are unknown, it was assumed that the reservoir would be open and that some degree of boating and PWC use would continue. Based on these assumptions and the growth rates predicted at other national recreation areas such as Curecanti and Lake Roosevelt, 1% was determined to be reasonable. Under this scenario, PWC use on a peak day in July would increase from 5 in 2002 to 6 in 2012 (table 16). Boating use would increase from 77 boats on a peak day to 85 in 2012.

WATER QUALITY

Most research on the effects of personal watercraft on water quality focuses on the impacts of two-stroke engines, and it is assumed that any impacts caused by these engines also apply to the personal watercraft powered by them. There is general agreement that two-stroke engines discharge a gas-oil mixture into the water. Fuel used in PWC engines contains many hydrocarbons, including benzene, toluene, ethylbenzene, and xylene (collectively referred to as BTEX). Polycyclic aromatic hydrocarbons (PAH) also are released

TABLE 16: WATERCRAFT PROJECTIONS – PEAK DAILY USE AT BIGHORN CANYON

Year	PWC	Boats	Total
2002	5	77	82
2012	6	85	91

Source: Annual increase in boating use was assumed to be 1% per year based on state and regional population projections for Montana and Wyoming, average increase in boating registrations, and lack of consistent growth in park visitation over the past 5–10 years.

from boat engines, including those in personal watercraft. These compounds are not found appreciably in the unburned fuel mixture, but rather are products of combustion. Discharges of all these compounds — BTEX and PAH — have potential adverse effects on water quality. A common gasoline additive, methyl tertiary butyl ether (MTBE) can be found in low concentrations ranging from 2% to 3% by volume in Montana and is not typically found in gasoline originating from refineries in Wyoming (Kuhn 2003).

A typical conventional (i.e., carbureted) two-stroke PWC engine discharges as much as 30% of its fuel unburned directly into the water (NPS 1999; CARB 1999). At common fuel consumption rates, an average two-hour ride on a personal watercraft may discharge 3 gallons of fuel into the water (NPS 1999). According to data from the California Air Resources Board, two-stroke PWC engines may consume 5 to 10 gallons of fuel per hour, of which up to 3.3 gallons per hour may be discharged unburned (CARB 1998b).

A recent study by the Tahoe Regional Planning Agency (2003) compared the concentrations of PAH compounds released into the water and found that the two-stroke carbureted outboard engine emitted lower PAH levels into the water than did the two-stroke direct-injected engine. The four-stroke carbureted outboard engine emitted the lowest PAH levels, as well as other gasoline-related contaminants into the water (TRPA 2003; CARB 2001). However, the two-stroke carbureted outboard engine emitted higher levels of benzene than the two-stroke direct-injected engine model (CARB 2001). PWC engines follow the same patterns of emission rates as outboard engines (CARB 2001). The TRPA (2003) study confirms other findings regarding emissions into the water and does not substantially change NPS conclusions regarding water quality impacts.

As described below, hydrocarbon (HC) discharges to water are expected to decrease substantially over the next 10 years due to mandated improvements in engine technology (EPA 1996a, 1997).

GUIDING REGULATIONS AND POLICIES

The Environmental Protection Agency has developed national recommended ambient water quality criteria for approximately 120 priority pollutants for the protection of both aquatic life and human health (related to ingestion of fish/shellfish or water) (EPA 1999a). These criteria have been adopted as enforceable standards by most states. The Environmental Protection Agency has not established any criteria for the protection of aquatic life for any of the PWC-related compounds stated above. For the human health criteria, however, the Environmental Protection Agency has established criteria for benzene, ethylbenzene, toluene, and several PAH compounds. There are no criteria for xylene.

The NPS *Management Policies* 2001 (NPS 2000c) state that the Park Service will "take all necessary actions to maintain or restore the quality of surface waters and ground waters within the parks consistent with the *Clean Water Act* and all other applicable federal, state, and local laws and regulations" (sec. 4.6.3).

Bighorn Lake does not have quantitative water quality data documenting the effects of PWC. To address water quality impacts that would potentially result from reinstated PWC use, water quality benchmarks were used in the absence of unit-specific data as a basic principle to guide the analysis.

Simply stated, a water quality standard defines the water quality goals of a waterbody by designating uses to be made of the water, by setting minimum criteria to protect the uses, and by preventing degradation of water quality through antidegradation provisions. The antidegradation policy is only one portion of a water quality standard. Part of this policy (40 CFR 131.12(a)(2)) strives to maintain water quality at existing levels if it is already better than the minimum criteria. Antidegradation should not be interpreted to mean that "no degradation" can or will occur, as even in the most pristine waters, degradation may be allowed for certain pollutants as long as it is temporary and short term (NPS 2001b).

Other considerations in assessing the magnitude of water quality impacts is the effect on those resources dependent on a certain quality or condition of water. Sensitive aquatic organisms, submerged aquatic vegetation, riparian areas, and wetlands are affected by changes in water quality from direct and indirect sources.

While many parks do have established water quality monitoring programs, the specific organic compounds emitted from personal watercraft are not systematically measured. In the absence of park-specific data, available water quality benchmarks or criteria and estimated discharge rates of organics were used as the basic tools to address water quality impacts potentially resulting from PWC use.

METHODOLOGY AND ASSUMPTIONS

In order to assess the magnitude of water quality impacts to park waters under the various PWC management alternatives, the following methods and assumptions were used:

1. The regulation at 40 CFR 131.12(a)(2) represents an overall goal or principle with regard to PWC use in that the national recreation area will strive to fully protect existing water quality so that "fishable / swimmable" uses and other existing or designated uses are maintained. Therefore, PWC use could not be authorized to the degree that it would lower this standard and affect these uses. To do so would potentially violate 40 CFR 131.10, which basically forbids the removal of an existing use (e.g., personal watercraft) because the activity was authorized knowing this level of pollution would occur.

2. State water quality standards governing the waters of the national recreation area were examined for pollutants whose concentration levels in gasoline were available in the literature and for which ecotoxicological and/or human health toxicity benchmarks were available in the literature.

3. Baseline water quality data (if available), especially for pollutants associated with two-stroke engines (PAH, hydrocarbons), were examined. MTBE may still be found in gasoline sold in Montana and although it is not expected to be found in gasoline in Wyoming, it is included in the analysis.

4. Since no models were available to predict concentrations in water of selected pollutants emitted by personal watercraft and motorboats, an approach was developed to provide estimates of whether PWC (and outboard motor) use over a particular time (for example, over a typical busy weekend day) would result in exceedance of the identified standards, criteria, or toxicity benchmarks. The approach is described in appendix A. Results of this approach were then taken into account, along with site-specific information about currents, mixing,

wind, turbidity, as well as the specific fate and transport characteristics of the pollutant involved (e.g., volatility), to assess the potential for the occurrence of adverse water quality impacts.

5. In general, the approach provides the information needed to calculate emissions to the receiving waterbody from personal watercraft (and, by estimation, from outboard motors) of selected hydrocarbons whose concentrations in the raw gasoline fuel were available in the literature and for which ecotoxicological and/or human health toxicity benchmarks could be acquired from the literature. The selected chemicals were benzene, MTBE and three PAH (benzo(a) pyrene, naphthalene, and 1-methyl naphthalene). The approach outlined a procedure to first estimate the emissions of these pollutants to the water per operational hour (based on literature values) and to then estimate the total loading of the pollutants into the water, based on the estimated hours of use. The approach then provided an estimate of how much water would be required to dilute the calculated emission loading to the level of the water quality standard or benchmark. That volume of water (referred to as the "threshold volume of water") was then compared to the total available volume of water.

6. The water quality standards for priority pollutants in Wyoming and Montana applicable to waters in Bighorn Lake were compared with the respective EPA standards and other benchmarks, and the lower, more restrictive, of the standards were used. (By complying with the more restrictive benchmarks, both state and federal criteria are satisfied.) Table 17 reflects current EPA water quality criteria and benchmarks used to assess water quality impacts.

7. The principal mechanisms that result in loss of the pollutant from the water were also considered. Many organic pollutants that are initially dissolved in the water volatilize to the atmosphere, especially if they have high vapor pressures, are lighter than water, and mixing occurs at the air/water interface. Other compounds that have low vapor pressure, low solubility, and high octanol/water partition coefficients tend to adhere to organic material and clays and eventually adsorb onto sediments. By considering movements of the organics through the water column, an assessment can be made as to whether there could be an issue with standards or benchmarks being exceeded, even on a short-term basis.

TABLE 17: ECOTOXICOLOGICAL BENCHMARKS AND HUMAN HEALTH CRITERIA FOR ORGANIC CHEMICALS

Chemical	Ecotoxicological Benchmark (μg/L)	Source	Human Health Criteria[b] (μg/L)	Source
Benzo(a)pyrene	0.014	Suter and Tsao 1996	0.0038	EPA 2002c
Naphthalene	62	Suter and Tsao 1996		
1-methyl naphthalene	34[a]	USFWS 2000	—	—
Benzene	130	Suter and Tsao 1996	1.2	WDEQ 2001a
MTBE[c]	51,000	Mancini et al. 2002	13	CA DHS 2002

a. Based on LC_{50} of 34 μg/L used for freshwater calculations.

b. Based on the consumption of water and fish.

c. Ecotoxicological benchmarks, which are considered preliminary chronic water quality criteria, are 18,000 μg/L for marine and 51,000 μg/L for freshwater. There is no EPA human health benchmark, but the California Department of Health Services (2002) has established a primary maximum contaminant level (MCL) of 13 μg/L.

8. The threshold volume of water was calculated in acre-feet (1 acre-foot = 1 acre of water 1 foot deep). For example, if results showed that for benzo(a)pyrene, 55 acre-feet of water would be needed to dilute the expected emissions to below the benchmark level, and the receiving body of water is a 100-acre reservoir with an average depth of 20 feet (= 2,000 acre-feet) and is well-mixed, then this would indicate little chance of a problem, especially when adding the effects of any other processes that contribute to the loss of benzo(a)pyrene from the water column. However, if the impact area is a 5-acre backwater averaging 2 feet deep (10 acre-feet), then there may be at least a short-term issue, especially if outboard emissions are added or there is little mixing in the area.

9. To assess cumulative impacts, emissions from other motorized boats were also determined, based on estimates of relative emissions of unburned fuel and hours of use. Emissions from two-stroke, carbureted outboard engines and four-stroke or direct injection engines at the national recreation area were then added to PWC emissions to yield a more complete estimation of loading to the receiving water body. Several studies have demonstrated that four-stroke engines are substantially cleaner than carbureted two-stroke engines, generating approximately 90% fewer emissions (NALMS 1999). Oregon Department of Environmental Quality estimates emissions from four-stroke and direct-injection two-stroke engines to be from 75% to 95% cleaner (ODEQ 1999). A distinction is made in the water quality analysis in order to differentiate between the two-stroke, carbureted outboard engines and the cleaner four-stroke, or two-stroke direct injection engines. The total emissions calculated from the numbers of four-stroke or direct injection engines will be reduced by 90%. The estimates used for relative loading from various engine types are obtained from available data.

10. Estimated reductions in emissions from personal watercraft and outboards are outlined by the U.S. Environmental Protection Agency over the next 10 years (see table 18).

    Key dates in this chronology begin with 1999, when the Environmental Protection Agency began to require production line testing for 75% HC reduction in new outboard motors, and 2000, when testing for 75% HC reduction in personal watercraft was started. By 2006 all new personal watercraft and outboards manufactured in the United States must have a 75% reduction in HC emissions. In 2005 and 2012 overall reductions in HC emissions are estimated to be 25% and 50%, respectively, in PWC and outboard motors. These estimates are based on estimates of the emissions reduction percentages and associated years reported by the U.S. Environmental Protection Agency (1996a), but with a one-year delay in the implementation of production line testing (EPA 1997). The 50% reduction estimated for 2012 was used in the calculations for alternatives A, B, and no-action in this assessment.

TABLE 18: ESTIMATED EPA REDUCTIONS IN WATERCRAFT EMISSIONS

Date	Action
1999	Environmental Protection Agency requires production line testing for 75% HC reduction in new outboards and begins to see reductions as newer models are introduced (EPA 1997).
2000	Environmental Protection Agency requires production line testing for 75% HC reduction in new personal watercraft and begins to see reductions as newer models are introduced (EPA 1997).
2005	Estimated 25% reduction in HC emissions overall as a result of newer models being gradually used (EPA 1996a; date modified in EPA 1997).
2006	Environmental Protection Agency fully implements production line testing for 75% HC reduction in new outboards and personal watercraft (EPA 1996a).
2012	Estimated 50% reduction in HC emissions overall (EPA 1996a; date modified in EPA 1997).

11. To evaluate water quality impacts at Bighorn Canyon National Recreation Area, water volumes and water quality calculations were analyzed for the mixing zone defined for Bighorn Lake. This mixing zone was identified as the volume of water between the minimum pool elevation (3,547 feet) and the top of the thermocline (located approximately 200 feet below the minimum pool elevation). Within this mixing zone, waters freely mix. The available volume of water available for mixing is 449,837 acre-feet. Additional information on the derivation of this estimate is found in the "Affected Environment" chapter. It is assumed for this analysis that all water vessels would operate within the canyon and north of the SouthNarrows. No water volumes from the area south of the SouthNarrows are include in the dilution values. It should be noted that current (March 2003) water levels are approximately 30 feet above the minimum conservation pool. At these low water elevations there would be no boating in the southern portion of the reservoir because the water elevation would be below the elevation of the launch facilities. Therefore, it is assumed for this analysis that all vessels would operate within the canyon area and northern portion of the reservoir.

12. PWC and motorboat numbers are provided at the beginning of this chapter in the "PWC and Other Boating Use Trends" section. PWC and boating use for the entire reservoir reflecting peak use month of July was used for the assessment of impacts to water quality. These estimates were based on park staff observations and statistics from various sources including visitor use information, regional population, and boating registration statistics. Estimation of the total motorized vessels (personal watercraft and other motorized boats) per day for the peak use month for 2002 was 82. Of that total, the numbers of PWC are estimated to be approximately 5 two-stroke carbureted engines. The total number of other motorboats estimated to operate at the reservoir during peak use month was approximately 77. As noted in table 19, of the 77 motorboats, 50 are assumed to be two-stroke, carbureted outboard engines (fishing type boats) and 27 are assumed to be four-stroke, or direct injection engines. Annual increases in boating and PWC use of 1% from 2002 to 2012 were assumed. Using this assumption, an estimation of the total motorized vessels per day for the peak use days for 2012 was 91. Of that total, the number of PWC are estimated to be approximately six. The total number of other motorboats estimated to operate at the reservoir during peak use days was approximately 85. Of the 85 motorboats, 55 are assumed to be two-stroke, carbureted outboard engines and 30 are assumed to be four-stroke, or direct injection engines.

TABLE 19: DISTRIBUTION OF VESSEL TYPE DURING PEAK USE DAYS AT BIGHORN CANYON

Vessel Type	Number of Vessels	
	2002	2012
Watercraft, Not Including Personal Watercraft		
Carbureted two-stroke	50	55
Four-stroke, or direct injection engines	27	30
Total watercraft, not including personal watercraft	77	85
Personal Watercraft		
Carbureted two-stroke engine (total)	5	6
All Vessels, Including Personal Watercraft		
Total vessels	82	91

13. The following describes how PWC and motorboat operations were evaluated to determine potential water quality impacts at Bighorn Lake:

    - The majority of motorboats operating within the Bighorn Lake are assumed to have two-stroke, carbureted outboard engines. All motorboats are assumed to have engines larger than 15 horsepower. Boats using four-stroke and direct injection engines are included in the analysis, assuming a 90% reduction of the resulting emissions.

    - Hours of use per various vessel types are based on park staff observation and estimates. Most PWC use involves cycling riders on and off the vessel, so they are heavily used at full throttle for approximately 2 hours. The same is assumed for four-stroke or direct injection engines. Fishing boats (predominantly two-stroke, carbureted outboard engines) tend to stay out longer, but are not operating at full throttle for much of the time. Assuming that operation of fishing boats averages 5.5 hours per day, only about 60 minutes of that time would be spent at full throttle. The remainder of the time would be spent at considerably slower speed. It was assumed that boats would discharge gasoline and its constituents at one-quarter of the rate expected at full throttle. The effective time at full throttle used in the analysis was estimated as 2 hours for two-stroke, carbureted engines.

    - Concentration of MTBE added to gasoline was assumed to be 3% by volume under the analysis for 2002 and 2012 (Kuhn 2003) (see the "Water Quality" section in the "Affected Environment" chapter).

    - When released to water, benzene is subject to rapid volatilization, with a half-life for evaporation of about 5 hours (EPA 2001). The loss of benzene from the water column is discussed qualitatively where applicable.

    - Some research shows that PAH, including those from personal watercraft emissions, adversely affect water quality via harmful phototoxic effects on ecologically sensitive plankton and other small water organisms (EPA 1998; Oris et al. 1998; Landrum et al. 1987; Mekenyan et al. 1994; Arfsten et al. 1996). This research indicates that PAH may have phototoxic effects at very low concentrations (less than 1 μg/L) in clear lakes with limited production of organic matter and high light penetration in shallow waters (Oris et al. 1998). Light penetration at Bighorn Lake is greatest (at a depth of 33 feet) at Yellowtail Dam where water is also the deepest, and decreases to a depth of 3 feet in the southern portion of the reservoir where the reservoir is eutrophic (NPS 1996b). The steep-walled canyon nature of northern and mid-portions of the reservoir and the eutrophic nature of the southern portion of the reservoir make it unlikely that phototoxic effects from PAH would occur.

IMPACT ANALYSIS AREA

The impact analysis area for water quality includes Bighorn Lake within the jurisdictional boundary of the Bighorn Canyon National Recreation Area. The impact analysis area does not include waters downstream of the Yellowtail Dam which are closed to motorized vessel use.

IMPACT TO WATER QUALITY FROM PWC USE

Given the above water quality issues and methodology and assumptions, the following impact thresholds were established in order to describe the relative changes in water quality (both overall, localized, short and long term, cumulatively, adverse and beneficial) under the various personal watercraft management alternatives.

Negligible: Impacts are chemical, physical, or biological effects that would not be detectable, would be well below water quality standards or criteria, and would be within historical or desired water quality conditions.

Minor: Impacts (chemical, physical, or biological effects) would be detectable but would be well below water quality standards or criteria and within historical or desired water quality conditions.

Moderate: Impacts (chemical, physical, or biological effects) would be detectable but would be at or below water quality standards or criteria; however, historical baseline or desired water quality conditions would be altered on a short-term basis.

Major: Impacts (chemical, physical, or biological effects) would be detectable and would be frequently altered from the historical baseline or desired water quality conditions; and/or chemical, physical, or biological water quality standards or criteria would be slightly and singularly exceeded on a short-term basis.

Impairment: Impacts are chemical, physical, or biological effects that would be detectable and that would be substantially and frequently altered from the historical baseline or desired water quality conditions and/or water quality standards, or criteria would be exceeded several times on a short-term and temporary basis. In addition, these adverse, major impacts to park resources and values would:

- contribute to deterioration of the park's water quality and aquatic resources to the extent that the park's purpose could not be fulfilled as established in its enabling legislation;
- affect resources key to the park's natural or cultural integrity or opportunities for enjoyment; or
- affect the resource whose conservation is identified as a goal in the park's general management plan or other park planning documents.

Impacts of Alternative A — Reinstate PWC Use under a Special Regulation as Previously Managed

Analysis. PWC use would be reinstated on Bighorn Lake in all locations of the national recreation area where it was allowed until November 6, 2002. PWC use would be allowed throughout the recreation area with exception of the closures listed the description of alternative A.

Under this alternative, it is assumed that PWC and other vessels with two-stroke carbureted engines would be converted to cleaner direct-injection or four-stroke engines in accordance with the Environmental Protection Agency's assumptions (40 CFR Parts 89-91, "Air Pollution Control; Gasoline Spark-Ignition and Spark-Ignition Engines, Exemptions;" Rule, 1996). Bighorn Canyon National Recreation Area would not accelerate this conversion from two-stroke to four-stroke engines.

It is acknowledged that PWC and other motorboats would not be operating at full throttle and would have variable discharge rates in flat-wake zones. However, due to the small aerial extent of these flat-wake zones coupled with the limited time spent in these areas by PWC and other motorized vessels, the effects on water quality are not likely to be detectable. Focus will remain on operation of these vessels in the non-restricted areas of Bighorn Lake.

An estimate of how much water would be required to dilute the calculated emission loading from PWC to the level of the water quality standard or benchmark is shown in table 20. That volume of water (referred to as the "threshold volume of water") was then compared to the total available volume of water in the mixing zone at Bighorn Lake (approximately 450,000 acre-feet).

The 2002 and 2012 threshold volumes to meet ecotoxicological benchmarks range from 0 to 16 acre-feet. These volumes are extremely small in relation to the volumes of water available (450,000 acre-feet in available mixing zone of Bighorn Lake), indicating that these pollutant loads would result in concentrations well below the ecotoxicological benchmarks. Consequently, negligible long-term adverse impacts are expected in 2002 and in 2012.

Threshold volumes required to meet human health benchmarks were also well below the volume available at Bighorn Lake. In 2002 and 2012 the threshold volume required to meet these human health benchmarks would range from 31 to 1,417 acre-feet, resulting in negligible long-term, adverse impacts to water quality.

The most limiting estimated threshold water volume required to meet human health benchmarks is for benzene. The threshold volumes required to meet the benzene human health benchmark are 1,417, and 850 acre-feet, for 2002 and 2012, respectively. For benzene, factors other than those discussed above that affect surface water concentrations (especially volatilization) also are considered, but were not incorporated into the estimate of threshold volume. The half-life of benzene in water is less than 5 hours at summer water temperatures near 30°C (Verschuren 1983; EPA 2001). Therefore, half the benzene in water would evaporate in less than 5 hours.

Overall, pollutant loads in 2012 would be lower than in 2002 because PWC use would only increase from 5 to 6 on a peak day and because of the 50% reduction in PWC and outboard motorboat engine emissions estimated by the Environmental Protection Agency (1997).

Cumulative Impacts. In addition to the personal watercraft that use Bighorn Lake, other two-stroke outboard motorboats, and to a lesser degree the four-stroke and direct injection engines would contribute pollutants to the water. A total of 1,344 non-PWC vessels in 2002 and 1,485 non-PWC vessels in 2012 are estimated during a peak use day.

Emissions were calculated for each vessel type for both 2002 and 2012 (see table 21). Emissions from four-stroke or direct injection engines were assumed to be 10% of emissions calculated for two-stroke outboard engines or for PWC (assuming all PWC's have two-stroke, carbureted engines). These emissions were summed. In 2012, the emissions calculated reflect a 50% reduction applied in order to incorporate EPA estimates of engine conversion based on the 1996 EPA regulations (EPA 1996a). The effective hours of use on a peak day for all engine types was 2 hours.

The calculated threshold volumes for pollutants emitted in 2002 by personal watercraft and other motorboats are approximately an order of magnitude greater than the threshold volumes due to personal watercraft alone. The cumulative threshold volumes based on ecotoxicological benchmarks would range from 0 to 226 acre-feet in 2002. Effects would be long-term because impacts from cumulative sources

TABLE 20: THRESHOLD WATER VOLUMES NEEDED TO DILUTE PWC EMISSIONS AT BIGHORN CANYON, ALTERNATIVE A

	Water Volumes Needed for Dilution (acre-feet)	
	2002	2012
Volume of water available in mixing zone	449,837 acre-feet	
Ecotoxicological Benchmarks[a]		
Benzo(a)pyrene (fuel and exhaust)	14	8
Naphthalene	5	3
1-methyl naphthalene	16	9
Benzene	13	8
MTBE[c]	0	0
Human Health Benchmarks[b]		
Benzo(a)pyrene (fuel and exhaust)	51	31
Benzene	1,417	850
MTBE[c]	157	94

a. Threshold volume (in acre-feet) below which ecotoxicological effects might occur.

b. Threshold volumes (in acre-feet) below which human health might be impacted.

c. MTBE assumed at 3% by volume in 2002–2012.

TABLE 21: THRESHOLD WATER VOLUMES NEEDED TO DILUTE ALL VESSEL EMISSIONS AT BIGHORN CANYON, ALTERNATIVE A

	Water Volumes Needed for Dilution (acre-feet)	
	2002	2012
Volume of water available in mixing zone	449,837 acre-feet	
Ecotoxicological Benchmarks[a]		
Benzo(a)pyrene (fuel and exhaust)	226	125
Naphthalene	63	35
1-methyl naphthalene	180	100
Benzene	151	84
MTBE[c]	0	0
Human Health Benchmarks[b]		
Benzo(a)pyrene (fuel and exhaust)	589	327
Benzene	16,362	9,099
MTBE[c]	1,810	1,007

a. Threshold volume (in acre-feet) below which ecotoxicological effects might occur.

b. Threshold volumes (in acre-feet) below which human health might be impacted.

c. MTBE assumed at 3% by volume in 2002 and 2012.

occur annually during each boating season. In 2012, ecotoxicological threshold volumes would decrease to a range of 0 to 125 acre-feet, despite an estimated 1% annual increase in the numbers of personal watercraft and other motorboats, because of the reduction of emissions expected from clean engine technology. Concentrations of all the organic contaminants evaluated are well below the water quality benchmarks and would likely not be detectable. Cumulative adverse ecological impacts would be negligible in both 2002 and 2012.

Based on the human health benchmarks, the calculated threshold volumes for benzo(a)pyrene emitted by personal watercraft and boats in 2002 and 2012 would be 589 and 327 acre-feet, respectively. The calculated threshold volume for benzene for 2002 and 2012 would be 16,362 and 9,099 acre-feet, respectively, resulting in negligible adverse impacts. The threshold volume for benzene in 2012 would be lower than in 2002 because of the 50% reduction in PWC and outboard motorboat engine emissions estimated by the Environmental Protection Agency (1997). Threshold volume required for dilution for MTBE would be 1,810 acre-feet in 2002 and be reduced to 1,007 acre-feet in 2012. The benzo(a)pyrene, benzene, and MTBE threshold volumes would be substantially lower than the available water volumes in Bighorn Lake, and therefore, would result in negligible, long-term, adverse impacts to human health.

Conclusion. Alternative A would have negligible long-term adverse effects on water quality based on ecotoxicological threshold volumes due to the reinstatement of PWC use. All cumulative pollutant loads in 2002 and 2012 from personal watercraft and other motorboats would be neglegible, and would be well below ecotoxicological benchmarks and criteria.

Adverse water quality impacts from PWC from benzo(a)pyrene, benzene and MTBE based on human health (ingestion of water and fish) benchmarks would be negligible in both 2002 and 2012, based on water quality criteria set by the Environmental Protection Agency, as well as water quality criteria for Wyoming and Montana. Cumulative impacts from personal watercraft and other watercraft would be negligible, adverse and long-term for benzo(a)pyrene, benzene and MTBE.

Implementation of this alternative would not result in an impairment of the water quality resource.

Impacts of Alternative B — Reinstate PWC Use under a Special Regulation with Additional Management Prescriptions

Analysis. As in alternative A, PWC use would be reinstated. In addition to those areas closed to PWC use as listed in alternative A, this alternative would include a closure of the reservoir and shoreline south of the area known as the SouthNarrows. As discussed in the "Methodology and Assumptions" section, the water level elevation at minimum conservation pool (as well as at the current elevation as of February 2003) would preclude use of PWC in the southern portion of the reservoir, including the SouthNarrows area, because the water level elevation is below the elevation of launch facilities.

As a result, this additional closure does not change the direct or indirect impacts on water quality from PWC relative to alternative A. Numbers of vessels in 2002 and 2012 remain the same and results of analysis are the same as under alternative A.

Cumulative Impacts. As in alternative A, cumulative adverse impacts from personal watercraft and other watercraft would be negligible and long-term for benzo(a)pyrene, benzene and MTBE. The additional closure of the SouthNarrows area would not change the cumulative impacts on water quality.

Conclusion. The adverse impacts to water quality from alternative B would be the same as alternative A. Closure of the SouthNarrows area to PWC use would not measurably change water quality impacts

because the water levels in this area are generally below the elevation of launch facilities in an average year. PWC use under alternative B would have negligible adverse effects on water quality based on ecotoxicological threshold volumes. All pollutant loads in 2002 and 2012 from personal watercraft and other motorboats would be neglibible and well below ecotoxicological benchmarks and criteria.

Adverse water quality impacts from PWC from benzo(a)pyrene, benzene and MTBE based on human health (ingestion of water and fish) benchmarks would be negligible in both 2002 and 2012, based on water quality criteria set by the Environmental Protection Agency as well as water quality criteria for Wyoming and Montana. Cumulative adverse impacts from personal watercraft and other watercraft would be negligible for benzo(a)pyrene, benzene and MTBE.

Implementation of this alternative would not result in an impairment of the water quality resource.

Impacts of the No-Action Alternative: Allow No PWC Use

Analysis. Under the no-action alternative, PWC use would not be reinstated on Bighorn Lake. Therefore, for the purpose of assessing impacts to water quality, it is assumed that personal watercraft would not contribute pollutants to the waters of Bighorn Lake.

The no-action alternative would have a beneficial impact on water quality in proportion to the relative numbers of personal watercraft and other motorboats.

Cumulative Impacts. Cumulative emissions would be less than under alternative A or B because of the elimination of PWC use. Despite the elimination of PWC use, activity by other motorboats in the high-use month of July would be the same as described under the previous alternatives, increasing from an estimated 77 boats in 2002, to 85 boats in 2012 (table 22). Assumptions for hours of use for each vessel type remain the same as in alternative A and B.

TABLE 22: THRESHOLD WATER VOLUMES NEEDED TO DILUTE ALL VESSEL EMISSIONS AT BIGHORN CANYON, NO-ACTION ALTERNATIVE

	Water Volumes Needed for Dilution (acre-feet)	
	2002	2012
Volume of water available in mixing zone	449,837 acre-feet	
Ecotoxicological Benchmarks[a]		
Benzo(a)pyrene (fuel and exhaust)	212	85
Naphthalene	58	34
1-methyl naphthalene	164	95
Benzene	138	80
MTBE[c]	0	0
Human Health Benchmarks[b]		
Benzo(a)pyrene (fuel and exhaust)	538	312
Benzene	14,945	8,670
MTBE[c]	1,653	959

a. Threshold volume (in acre-feet) below which ecotoxicological effects might occur.

b. Threshold volumes (in acre-feet) below which human health might be impacted.

c. MTBE assumed at 3% by volume in 2002 and 2012.

Threshold volumes in both areas in 2002 and 2012 based on ecotoxicological benchmarks for pollutants and based on the human health benchmarks for benzo(a)pyrene, benzene and MTBE are all substantially lower than the water volumes available. Therefore, emissions from motorboats and a reduced number of personal watercraft would have a negligible, long-term adverse impact on water quality.

The estimated threshold volume for benzene, based on EPA water quality criteria, is again, the most limiting. Threshold volumes for benzene (human health based) are 14,945 and 8,670 acre-feet in 2002 and 2012, However, these adverse impacts are expected to be negligible even without considering the effects of the half life of benzene.

Conclusion. The no-action alternative would have a beneficial impact on water quality. Pollutant loads from personal watercraft would be eliminated. Cumulative impacts from the remaining motorboats would be negligible adverse in 2002 and 2012 for all ecotoxicological and human health benchmarks.

Implementation of this alternative would not result in an impairment of the water quality resource.

AIR QUALITY

Personal watercraft emit various compounds that pollute the air. A typical conventional (i.e., carbureted) two-stroke PWC engine discharges as much as 30% of its fuel unburned directly into the water (NPS 1999; CARB 1999). At common fuel consumption rates, an average two-hour ride on a personal watercraft may discharge 3 gallons of fuel into the water (NPS 1999). According to data from the California Air Resources Board, two-stroke PWC engines may consume 5 to 10 gallons of fuel per hour, of which up to 3.3 gallons per hour may be discharged unburned (CARB 1998b). The combustion process results in emissions of air pollutants such as volatile organic compounds (VOC), nitrogen oxides (NO_x), particulate matter (PM), and carbon monoxide (CO). Personal watercraft also emit fuel components such as PAH that are known to cause adverse health effects.

Low-emissions engines, including both four-stroke engines and direct-injection two-stroke engines, generate reduced amounts of most air pollutants, including carbon monoxide, particulate matter, hydrocarbons, and volatile organic compounds. However, the low-emission engines produce more nitrogen oxides than do carbureted two-stroke engines (EPA 1996a) and the two-stroke direct injected engine has been shown to generate more airborne-particulate PAH emissions, a class of volatile organic compounds, than the two-stroke carbureted engines (Kado et al. 2000). The Environmental Protection Agency estimates that conversion to four-stroke engines and two-stroke direct injection will both result in an increase in the level of nitrogen oxides produced by personal watercraft engines. In order to meet stringent hydrocarbon emission reduction contained in the EPA final rule, Environmental Protection Agency estimates that manufacturers will need to recalibrate their engines to run at leaner air-fuel ratios, resulting in higher combustion temperatures, more complete combustion, and some increase in nitrogen oxide formation. In addition, conversion to two-stroke direct inject and four-stroke technology have little internal exhaust gas recirculation (EGR) which could reduce emission rates of nitrogen oxides (EPA 1996a).

Even though PWC engine exhaust is usually routed below the waterline, a portion of the exhaust gases go into the air. These air pollutants may adversely impact park visitor and employee health as well as sensitive park resources. For example, in the presence of sunlight VOC[3] and NO_x emissions combine to

3. Hydrocarbon emissions from internal combustion are characterized in various references and regulations as total hydrocarbons (THC), hydrocarbons (HC), volatile organic compounds (VOC), and reactive organic gases (ROG), as well as other terms. While there are technical differences among some of these terms, the quantitative differences are negligible for purposes of this environmental analysis. The remainder of this discussion describes all hydrocarbon emissions as HC, which is the term used in the EPA regulation for control of emissions from marine engines.

form ozone (O_3). O_3 causes respiratory problems in humans, including cough, airway irritation, and chest pain during inhalations (EPA 1996c). O_3 is also toxic to sensitive species of vegetation. It causes visible foliar injury, decreases plant growth, and increases plant susceptibility to insects and disease (EPA 1996c). CO can affect humans as well. It interferes with the oxygen carrying capacity of blood, resulting in lack of oxygen to tissues. NO_x and PM emissions associated with PWC use can also degrade visibility (CARB 1997; EPA 2000b). NO_x can also contribute to acid deposition effects on plants, water, and soil. However, because emission estimates show that NO_x from personal watercraft are minimal (less than 5 tons per year), acid deposition effects attributable to personal watercraft use are expected to be minimal.

GUIDING REGULATIONS AND POLICIES

Clean Air Act. The *Clean Air Act* established national ambient air quality standards (NAAQS) to protect the public health and welfare from air pollution. The act also established the prevention of significant deterioration (PSD) of air quality program to protect the air in relatively clean areas. One purpose of this program is to preserve, protect, and enhance air quality in areas of special national or regional natural, recreational, scenic, or historic value (42 USC 7401 et seq.). The program also includes a classification approach for controlling air pollution.

- Class I areas are afforded the greatest degree of air quality protection. Very little deterioration of air quality is allowed in these areas, and the unit manager has an affirmative responsibility to protect visibility and all other Class I area air quality related values from the adverse effects of air pollution. There are no Class I areas within or adjacent to Bighorn Canyon National Recreation Area.

- Class II areas include all national park system areas not designated as Class I, and the *Clean Air Act* allows only moderate air quality deterioration in these areas. In no case, however, may pollution concentrations violate any of the national ambient air quality standards. Bighorn Canyon is designated a Class II area.

Conformity Requirements. National park system areas that do not meet the national ambient air quality standards or whose resources are already being adversely affected by current ambient levels require a greater degree of consideration and scrutiny by NPS managers. Areas that do not meet national air quality standards for any pollutant are designated as nonattainment areas. Section 176 of the *Clean Air Act* states:

No department, agency, or instrumentality of the Federal Government shall engage in, support in any way or provide financial assistance for, license or permit, or approve, any activity which does not conform to an implementation plan [of the State]. . . . [T]he assurance of conformity to such a plan shall be an affirmative responsibility of the head of such department, agency or instrumentality.

Essentially, federal agencies must ensure that any action taken does not interfere with a state's plan to attain and maintain the national ambient air quality standards in designated nonattainment and maintenance areas. In making decisions regarding PWC use within a designated nonattainment or maintenance area, park managers should discuss their plans with the appropriate state air pollution control agency to determine the applicability of conformity requirements. Bighorn Canyon is within an attainment area for all pollutants, so the conformity requirements do not apply to this unit.

Applicable PWC Emission Standards. The Environmental Protection Agency issued the gasoline marine engine final rule in August 1996. The rule, which took effect in 1998, affects manufacturers of new outboard engines and the type of inboard engines used in personal watercraft. The agency adopted a phased approach to reduce emissions. The current emission standards were set at levels that are

achievable by existing personal watercraft. By 2006, PWC manufacturers will be required to meet a corporate average emission standard that is equivalent to a 75% reduction in HC emissions. (The corporate average standard allows manufacturers to build some engines to emission levels lower than the standard and some engines to emission levels higher than the standard, and to employ a mix of technology types, as long as the overall corporate average is at or below the standard.) Because the actual reduction in emissions is dependent on the sale of lower-emitting personal watercraft, the Environmental Protection Agency estimated that a 50% emission reduction in the national outboard/PWC HC inventory will be achieved by 2020, and a 75% emission reduction by 2030.

NPS Organic Act and Management Policies. The NPS *Organic Act of 1916* (16 USC 1, et seq.) and the NPS *Management Policies* 2001(NPS 2000c) guide the protection of park and wilderness areas. The general mandates of the *Organic Act* state that the National Park Service will:

promote and regulate the use of . . . national parks . . . by such means and measures as conform to the fundamental purpose of the said parks, . . . which purpose is to conserve the scenery and the natural and historic objects and the wildlife therein and to provide for the enjoyment of the same in such manner and by such means as will leave them unimpaired for the enjoyment of future generations (16 USC 1).

Under its NPS *Management Policies* 2001(NPS 2000c) the National Park Service will:

> seek to perpetuate the best possible air quality in parks to (1) preserve natural resources and systems; (2) preserve cultural resources; and (3) sustain visitor enjoyment, human health, and scenic vistas (sec. 4.7.1).

The NPS *Management Policies* (NPS 2000c) further state that the National Park Service will assume an aggressive role in promoting and pursuing measures to protect air quality related values from the adverse impacts of air pollution. In cases of doubt as to the impacts of existing or potential air pollution on park resources, the National Park Service "will err on the side of protecting air quality and related values for future generations."

The *Organic Act* and the *NPS Management Policies* (NPS 2000c) apply equally to all areas of the national park system, regardless of *Clean Air Act* designations. Therefore, the National Park Service will protect resources at both Class I and Class II designated units. Furthermore, the NPS *Organic Act* and *Management Policies* provide additional protection beyond that afforded by the Clean Air Act's national ambient air quality standards alone because the National Park Service has documented that specific park air quality related values can be adversely affected at levels below the national standards or by pollutants for which no standard exists.

METHODOLOGY AND ASSUMPTIONS

In order to assess the level of PWC air quality impacts resulting from a given management alternative, the following methods and assumptions were used:

1. The national ambient air quality standards and state/local air quality standards as presented in the "Affected Environment" chapter (if applicable) were examined for each pollutant.

2. Air quality designations for the surrounding area were determined. Bighorn Canyon is in an attainment area for each pollutant.

3. There is no monitoring location near the recreation area that provides representative ambient data. Based on data from the Montana PPAD and the Wyoming Air Quality Division, as described in the "Affected Environment" chapter, all highest maximum concentrations for each pollutant are below the national ambient air quality standards (NAAQS).

4. Typical use patterns of motorized watercraft were identified as outlined in the "PWC and Boating Use Trends" section.

5. The rated horsepower, average engine load, and other relevant parameters for each watercraft type were taken from default assumptions in the EPA NONROAD model. This model is used to calculate emissions of criteria pollutants from the operation of nonroad spark-ignition type engines, including personal watercraft. The model allows assumptions to be made regarding the mix of engine types that will be phased in as new engine standards come into effect, and increasing numbers of personal watercraft will be of the cleaner-burning four-stroke type.

6. Hydrocarbon emissions from internal combustion are characterized in various references and regulations as total hydrocarbons (THC), hydrocarbons (HC), volatile organic compounds (VOC), and reactive organic gases (ROG), as well as other terms. While there are technical differences among some of these terms, the quantitative differences are negligible for purposes of this environmental analysis. The remainder of this discussion describes all hydrocarbon emissions as HC, which is the term used in the EPA regulation for control of emissions from marine engines.

7. PAH are released during the combustion of fuel, though some PAH are also found in unburned gasoline. Kado et al. 2000 indicated that changing from two-stroke carbureted engines to two-stroke direct-injection engines may result in increases of airborne particulate-associated PAH. The same study indicated that four-stroke engines have considerably less PAH emissions than two-stroke engines[4]. A subsequent study of airborne emissions indicated a potential health risk from toxic pollutants in areas of high concentration of exhaust from many engines, such as in an engine maintenance shop (Kado, Kuzmicky, and Okamoto 2001).

8. Any reductions in emissions resulting from implementing control strategies were taken into account, as were changes in emissions resulting from increased or decreased usage.

9. Studies regarding ozone injury on sensitive plants found in the recreational area were requested, but none were available for Bighorn Canyon.

10. A calculation referred to as SUM06 (ppm-hours) was used for assessing regional ozone exposure levels. These data are collected from rural and urban monitoring sites. The highest three-month, five-year average commonly used for the area was determined by reviewing ambient air quality data.

11. Visibility impairment was determined from local monitoring data, or from qualitative evidence such as personal observations and photographs.

12. The air quality impacts of the various alternatives were assessed by considering the existing air quality levels and the air quality related values present, and by using the estimated

4. It is noted that only one engine of each type, two-stroke carbureted, two-stroke direct injection, and four-stroke, was tested.

emissions and any applicable, EPA-approved air quality models. Estimated reductions in hydrocarbon emissions would be the same as those described for water quality.

13. For cumulative impacts, the assessment was completed quantitatively with respect to anticipated use of the national recreational area by other recreational watercraft based on emission factors and assumption in EPA's NONROAD model. Types of craft assessed for quantitative cumulative impacts included outboard spark-ignition type engines and PWC. Other sources of air pollutants in the area were also considered in the cumulative analysis through a review of the state implementation plan, county records, and the use of best professional judgment.

14. Pollutant emissions were calculated for 2002 and 2012. As described in the "Water Quality" section, estimates of watercraft use were based on park staff observations and statistics from various sources including the *Master Plan*, Montana and Wyoming State population projections, and National Marine Manufacturers Association boating registration statistics. For 2002, it was assumed that there were 10,118 combined PWC and boat trips, as shown previously in table 13 in the "PWC and Boating Use Trends" section. PWC use was assumed at 459 machines, each of which was assumed to engage in one trip that was 2 hours in duration (approximately 4% of all watercraft trips). The non-PWC trips were assumed to be 6,278 outboard engine boats (65% of non-PWC) and 3,381 inboard engine boats (35%), which are used for fishing and pleasure. The average trip duration for non-PWC boats was estimated to be 5.5 hours, mostly at low throttle/speed, with engine emissions the equivalent of 2 hours at full throttle. For 2002, it was assumed that all PWC and outboard engines at Bighorn Canyon were carbureted two-stroke (dirty) engines, and that all inboard engines were four-stroke (clean) engines.

    Between 2002 and 2012, some carbureted two-stroke PWC and outboards would be replaced with watercraft with the cleaner direct injection two-stroke, electric fuel injection two-stroke, or four-stroke engines. This replacement would occur as a result of the EPA requirement for manufacturers to supply the cleaner engines. Consistent with EPA forecasts, it was assumed that the introduction of cleaner engines would result in a 50% reduction of HC emissions for each engine type by 2012.

    It was also assumed that 50% of the replaced carbureted two-stroke PWC would be direct injection two-stroke, and 50% would be four-stroke. Twenty-five percent of the replaced carbureted two-stroke outboards would be direct injection two-stroke, 25% would be electric fuel injection two-stroke, and 50% would be four-stroke.

PWC impact thresholds for air quality are dependent on the type of pollutants produced, the background air quality, and the pollution-sensitive resources (air quality related values) present. Impact thresholds may be qualitative (e.g., photos of degraded visibility) or quantitative (e.g., based on impacts to air quality related values or federal air quality standards, or emissions based), depending on what type of information is appropriate or available.

Two categories for potential airborne pollution impacts from personal watercraft are analyzed: impacts on human health resources and impacts on air quality related values in the impact analysis area. Thresholds for each impact category (negligible, minor, moderate, and major) are discussed for each impact topic.

IMPACT ANALYSIS AREA

The impact analysis area for air quality includes the immediate location of PWC use and the surrounding national recreation area where air pollutants may accumulate. More specifically, the impact analysis area is Bighorn Canyon plus a 100-foot-wide strip inland. It is assumed that air pollutants would dissipate beyond 100 feet due to air currents.

IMPACT TO HUMAN HEALTH FROM AIRBORNE POLLUTANTS RELATED TO PWC USE

The following impact thresholds for an attainment area have been defined for analyzing impacts to human health from airborne pollutants — CO, PM_{10}, HC, and NO_x. Sulfur oxides (SO_x) are not included because they are emitted by personal watercraft in very small quantities.

	Activity Analyzed	Current Air Quality
Negligible:	Emissions would be less than and 50 tons/year for each pollutant.	The first highest three-year maximum for each pollutant is less than NAAQS.
Minor:	Emissions would be less than and 100 tons/year for each pollutant.	The first highest three-year maximum for each pollutant is less than NAAQS.
Moderate:	Emissions would be greater or than or equal to 100 tons/year for any pollutant.	The first highest three-year maximum for each pollutant is greater than NAAQS.
Major:	Emissions levels would be and greater than or equal to 250 tons/year for any pollutant.	The first highest three-year maximum for each pollutant is greater than NAAQS.

Impairment: Impacts would:

- have a major adverse effect on park resources and values; or
- contribute to deterioration of the park's air quality to the extent the park's purpose could not be fulfilled as established in its enabling legislation; or
- affect resources key to the park's natural or cultural integrity or opportunities for enjoyment; or
- affect the resource whose conservation is identified as a goal in the park's master plan or other park planning documents.

Both HC and NO_x are ozone precursors in the presence of sunlight and are evaluated separately in lieu of ozone, which is formed as a secondary pollutant. (Note that in attainment areas the *Clean Air Act* does not require that NO_x be counted as an ozone precursor).

Impacts of Alternative A — Reinstate PWC Use under a Special Regulation as Previously Managed

Analysis. In alternative A, PWC use would be reinstated and managed under the management strategies that were in place prior to closure. Based on data provided in the "PWC and Boating Use Trends" section,

PWC annual use was estimated to be 459 PWC in 2002, increasing at approximately 1% annually to 507 PWC in 2012.

The impacts to human health from airborne pollutants from PWC use are presented in table 23. Adverse impacts related to PWC use in 2002 would be negligible for CO, PM_{10}, HC, and NO_x. In 2012, human-health-related air quality impacts reflect the predicted 1% annual increase in PWC activity and a forecasted 50% reduction in engine HC emission rates compared to 1998. Reductions in emissions of all pollutants, except for NO_x, which is predicted to increase by a very small amount, would occur as a result of new engine technology required by the Environmental Protection Agency. This increase would occur because the design in two-stroke direct-injection and four-stroke engines required to achieve substantial HC reductions results in slightly higher NO_x emissions. Impacts to human health from PWC air pollutants in 2012 would remain negligible for all pollutants.

As carbureted two-strike engines are converted to cleaner engines, some increase in PAH emissions could occur related to two-stroke direct-injection engines (Kado et al. 2000). However, these increases would be offset by the reduction in PAH that would occur with conversion to four-stroke engines. The human health risk from PAH would be negligible adverse in 2002 and 2012.

Cumulative Impacts. Emissions of other motorized watercraft are assessed quantitatively in combination with PWC, taking into consideration regional and local air pollution sources. As described in the air quality "Methodology and Assumptions" section, boats accounted for approximately 96% of the annual motorized watercraft activity at Bighorn Canyon in 2002. The combined emissions from PWC and other boats are provided in table 24. Overall, cumulative adverse impacts to human health from airborne pollutants in 2002 would be minor for CO and negligible for PM_{10}, HC and NO_x.

Combined emissions of CO would increase from 2002 to 2012. This would occur because two types of cleaner (i.e., reduced HC) outboard engines – fuel injection two-stroke and four-stroke – have higher CO emissions than the carbureted two-stroke engines. As boating increases annually and two-stroke engines are replaced with these cleaner engines, CO emissions would also increase. Although monitoring data are not available for CO in the area of Bighorn Canyon, ambient CO levels are assumed to be below NAAQS within this area, based on data from the Montana PPAD and the Wyoming Air Quality Division, and reportedly low traffic congestion. High local CO usually occurs in areas of severe traffic congestion on major urban roadways, which is not the situation at Bighorn Canyon. The introduction of cleaner engines would also result in an increase in NO_x as described earlier.

TABLE 23: PWC EMISSIONS AND HUMAN HEALTH IMPACT LEVELS AT BIGHORN CANYON, ALTERNATIVE A

	CO		PM_{10}		HC		NO_x	
	2002	2012	2002	2012	2002	2012	2002	2012
Annual Emissions (tons/year)	5.5	4.8	0.1	0.1	2.7	1.5	<0.1	0.1
Impact Level	Negligible	Negligible	Negligible	Negligible	Negligible	Negligible	Negligible	Negligible

TABLE 24: PWC AND MOTORIZED BOAT EMISSIONS AND HUMAN HEALTH IMPACT LEVELS AT BIGHORN CANYON, ALTERNATIVE A

	CO		PM_{10}		HC		NO_x	
	2002	2012	2002	2012	2002	2012	2002	2012
Annual Emissions (tons/year)	52	61	1.2	0.9	19	11	0.8	1.4
Impact Level	Minor	Minor	Negligible	Negligible	Negligible	Negligible	Negligible	Negligible

Emission rates of HC would be reduced by approximately 43% between 2002 and 2012 as a result of technological improvements in marine engines, even with an estimated 1% increase in motorized boating activity at Bighorn Canyon. Additional cumulative emissions reductions beyond 2012 are likely, as manufacturers implement EPA regulations targeted at improving motorized watercraft engine performance.

Overall, cumulative adverse impacts to human health from airborne pollutants in 2012 would be negligible for PM_{10}, HC, and NO_x, and minor for CO.

Conclusion. Alternative A would result in negligible adverse impacts to human heath related to the PWC airborne pollutants CO, PM_{10}, HC and NO_x. The risk from PAH would also be negligible adverse. In 2012, there would be an increase in NO_x emissions and a decrease in emissions of the other pollutants; however, the impact level for these pollutants would remain negligible.

Cumulative emission levels from boating and PWC use at Bighorn Canyon would be negligible adverse for PM_{10}, HC and NO_x, and minor adverse for CO in 2002 and 2012. CO and NO_x emissions would increase from 2002 to 2012 because of increased boating activity and cleaner engines that have higher CO and NO_x emissions. Although there would be an increase in NO_x emissions in 2012, the greater reduction in HC emissions would result in a beneficial impact to regional ozone concentrations and would maintain or improve existing air quality conditions. Overall, PWC emissions of HC are estimated to be 14% of the cumulative boating emissions in 2002 and 2012.

Implementation of this alternative would not result in an impairment of air quality.

Impacts of Alternative B — Reinstate PWC Use under a Special Regulation with Additional Management Prescriptions

Analysis. Under this alternative, the use of Bighorn Lake by PWC would be reinstated with some additional restrictions to the management strategies outlined in alternative A. The additional restrictions would include a closure of the reservoir and shoreline south of the area known as the South Narrows to PWC use. These additional restrictions would not affect the number of PWC using the reservoir in 2002 and 2012. As a result, human-health air quality impacts from alternative B would be the same as alternative A for 2002 and 2012, and would be negligible and long-term adverse for CO, PM_{10}, HC, and NO_x. The human health risk from PAH would also be negligible adverse in 2002 and 2012.

Cumulative Impacts. Under alternative B, cumulative impacts from all boating use on Bighorn Canyon would be the same as alternative A because, similar to PWC use, boating numbers would not be affected by the additional management restrictions. Adverse impacts to human health from air pollutants in 2002 would be negligible for PM_{10}, HC, and NO_x, and minor for CO. In 2012, levels for PM_{10}, HC, and NO_x would remain negligible and CO would remain minor.

Conclusion. Alternative B would result in the same air quality impacts to human health from PWC emissions as alternative A because additional PWC management strategies would not noticeably affect PWC emissions. As in alternative A, negligible adverse impacts for CO, HC, PM_{10} and NO_x would occur for 2002 and 2012. The risk from PAH would also be negligible adverse in 2002 and 2012.

Cumulative adverse impacts from PWC and other boating emissions at Bighorn Canyon would be minor for CO and negligible for PM_{10}, HC, and NO_x in 2002. In 2012, impacts for the all pollutants would remain at 2002 levels although a beneficial impact to regional ozone emissions would occur due to a

reduction in HC emissions. PWC contribution to emissions of HC are estimated to be 14% of the cumulative boating emissions in 2002 and 2012.

Implementation of this alternative would not result in an impairment of air quality.

Impacts of the No-Action Alternative: Allow No PWC Use

Analysis. PWC use would not be reinstated under this alternative. As a result, PWC emissions would be eliminated within the recreation area, resulting in a beneficial impact. The small number of personal watercraft that would be eliminated would result in only a negligible change to air quality.

Cumulative Impacts. As described for alternative A, motorized boats are a primary source of air pollutants within the national recreation area and would continue to contribute to cumulative pollutants. Under the no-action alternative, PWC contribution to overall cumulative emissions would be less than in alternatives A and B. Cumulative impacts to human health from boating emissions in 2002 would be negligible for CO, PM_{10}, HC, and NO_x (see table 25), and would be reduced relative to the other alternatives due to the beneficial impacts from reduction of PWC use. Adverse impacts in 2012 would be the same as in 2002, except the impact of CO would increase from negligible to minor. Emissions of CO and NO_x would increase between 2002 and 2012 as a result of cleaner engines and increased boating activity, as described for alternative A. Even with the projected 1% increase in boating activity, HC emissions in 2012 would be less than in 2002 because of the continuing introduction of cleaner engines. Overall impact to regional ozone levels in 2012 would be beneficial, as described for alternative A.

Conclusion. Continuing the ban on PWC use at Bighorn Canyon National Recreation Area would result in beneficial impacts on human health relative to the other alternatives for CO, HC, PM_{10} and NO_x for the years 2002 and 2012 because PWC emissions would be eliminated. The risk from PAH would also be negligible in 2002 and 2012.

Cumulative adverse impacts to human health from airborne pollutants in 2002 would be negligible for all pollutants analyzed. In 2012, adverse impacts to human health from boating emissions would remain negligible for PM_{10}, HC and NO_x, while the impact for CO would increase from negligible to minor. Increased CO emissions and slightly increased NO_x emissions in 2012 would result from increased boating activity and the conversion to new technology engines. The reductions in HC emissions would contribute to a beneficial impact to regional ozone levels. The risk from PAH would also be negligible in 2002 and 2012.

Implementation of this alternative would not result in impairment of air quality.

TABLE 25: MOTORIZED BOAT EMISSIONS AND HUMAN HEALTH IMPACT LEVELS AT BIGHORN CANYON, NO-ACTION ALTERNATIVE

	CO		PM_{10}		HC		NO_x	
	2002	2012	2002	2012	2002	2012	2002	2012
Annual Emissions (tons/year)	47	56	1.0	0.8	16	9	0.8	1.4
Impact Level	Negligible	Minor	Negligible	Negligible	Negligible	Negligible	Negligible	Negligible

IMPACT TO AIR QUALITY RELATED VALUES FROM PWC POLLUTANTS

Environmental resources and values including visibility and biological resources (specifically ozone effects on plants) may be affected by airborne pollutants including O_3, NO_x, HC emitted from personal watercraft and other sources. $PM_{2.5}$ and NO_x emissions are evaluated for visibility impairment. HC and NO_x are precursors to the formation of ozone and are evaluated in lieu of ozone emissions.

To assess the impact of ozone on plants, the five-year ozone index value, called SUM06 was calculated. The Air Resources Division of the National Park Service, based on local monitoring site data, developed SUM06 values used in this analysis.

To assess a level of impact on air quality related values from airborne pollutants, both the emissions of each pollutant related to motorized watercraft activity and the background air quality must be evaluated and then considered according to the thresholds defined below.

	Activity Analyzed		Current Air Quality
Negligible:	Emissions would be less than 50 tons/year for each pollutant.	**and**	There are no perceptible visibility impacts (photos or anecdotal evidence). and There is no observed ozone injury on plants. and SUM06 ozone is less than 12 ppm-hr.
Minor:	Emissions would be less than 100 tons/year for each pollutant.	**and**	SUM06 ozone is less than 15 ppm-hr.
Moderate:	Emissions would be greater than 100 tons/year for any pollutant. or Visibility impacts from cumulative PWC emissions would be likely (based on past visual observations).	**or**	Ozone injury symptoms are identifiable on plants. and SUM06 ozone is less than 25 ppm-hr.
Major:	Emissions would be equal to or greater than 250 tons/year for any pollutant. or Visibility impacts from cumulative PWC emissions would be likely (based on modeling or monitoring).	**and**	Ozone injury symptoms are identifiable on plants. or SUM06 ozone is greater than 25 ppm-hr.

Impairment: Air quality related values in the park would be adversely affected. In addition, impacts would:

- have a major adverse effect on park resources and values; and
- contribute to deterioration of the park's air quality to the extent that the park's purpose could not be fulfilled as established in its enabling legislation; or
- affect resources key to the park's natural or cultural integrity or opportunities for enjoyment; or
- affect the resource whose conservation is identified as a goal in the park's general management plan or other park planning documents.

According to the NPS SUM06 ozone index maps for year 2000 based on rural monitoring sites, the ozone level for Bighorn Canyon is 6–12 ppm-hr.

Impacts of Alternative A — Reinstate PWC Use under a Special Regulation as Previously Managed

Analysis. PWC use at Bighorn Canyon would be reinstated according to management strategies in place prior to closure. There would be no locational restrictions or changes in speed limits from those previously enforced. As outlined in the "PWC and Boating Use Trends" section, annual use was estimated to be 459 PWC in 2002, increasing at approximately 1% annually to 507 PWC in 2012.

Table 26 presents the annual PWC emissions, SUM06 data, and qualitative assessment of visibility and ozone-related effects for 2002 and 2012 under this alternative. Emissions of each pollutant would be less than 50 tons/year in both 2002 and 2012 and no visibility impacts or ozone injury on plants has been observed. The SUM06 ozone data show ozone levels to be in the range of 6 to 12 ppm-hrs, which indicates a negligible regional impact. Therefore, the adverse impact of PWC emissions on air quality related values from PWC pollutants would be negligible.

Cumulative Impacts. The cumulative impact analysis includes other motorized watercraft use, taking into consideration regional use trends, as well as current and future emission levels. Cumulative emissions and impacts of all PWC watercraft and other boating activities under alternative A are shown in table 27.

HC, NO_x and $PM_{2.5}$ emissions would be less than 50 tons/year in 2002 and 2012. As described above, SUM06 ozone values for the region are in the range of 6 to 12 ppm-hours. The SUM06 values are low and there are no documented ozone effects in the national recreation area. In 2012, NO_x emissions would increase, but there would be a much greater reduction in HC emissions, resulting in a beneficial contribution to ozone levels. Predicted year 2012 regional SUM06 ozone levels would be in the same range as year 2002. The cumulative adverse impacts to air quality related values at Bighorn Canyon in 2012 would continue to be negligible.

TABLE 26: AIR QUALITY RELATED IMPACTS FROM PWC EMISSIONS AT BIGHORN CANYON, ALTERNATIVE A

Emissions (tons/year)						Visibility Observations and Forecast		Impact Level	
HC		NO_x		$PM_{2.5}$					
2002	2012	2002	2012	2002	2012	2002	2012	2002	2012
2.7	1.5	<0.1	0.1	0.1	0.1	No perceptible visibility impacts	No perceptible visibility impacts	Negligible	Negligible
				Local Ozone Effects		SUM06 Index Value			
Ozone injury to plants (injury symptoms and monitoring data)				No park specific effects documented	No park specific effects anticipated	6–12 ppm-hrs (rural monitoring)	6–12 ppm-hrs (rural monitoring) Assumed to be no greater than in 2002		

Source for SUM06 values: NPS Air Quality Division year 2000 monitoring data.

TABLE 27: CUMULATIVE AIR QUALITY RELATED IMPACTS FROM PWC AND OTHER MOTORIZED BOAT EMISSIONS AT BIGHORN CANYON, ALTERNATIVE A

Emissions (tons/year)						Visibility Observations and Forecast		Impact Level	
HC		NO_x		$PM_{2.5}$					
2002	2012	2002	2012	2002	2012	2002	2012	2002	2012
19	11	0.8	1.4	1.1	0.8	No perceptible visibility impacts	No perceptible visibility impacts	Negligible	Negligible
				Local Ozone Effects		SUM06 Index Value			
Ozone injury to plants (injury symptoms and monitoring data)				No park specific effects documented	No park specific effects anticipated	6–12 ppm-hrs (rural monitoring)	6–12 ppm-hrs (rural monitoring) Assumed to be no greater than in 2002		

Source for SUM06 values: NPS Air Quality Division year 2000 monitoring data.

Conclusion. Negligible adverse impacts to air quality related values would occur from PWC emissions in 2002 and 2012. This conclusion is based on pollutant emissions of less than 50 tons per year, no observed visibility impacts or ozone-related plant injury, and low regional SUM06 values. Cumulative emissions from motorized boats and PWC in both 2002 and 2012 would result in negligible adverse impacts to air quality related values. Beneficial effects to ozone levels would occur in 2012 resulting from the expected reduction in HC emissions from new engine technology.

Implementation of this alternative would not result in an impairment of air quality related values.

Impacts of Alternative B — Reinstate PWC Use under a Special Regulation with Additional Management Prescriptions

Analysis. In alternative B the annual number of personal watercraft using Bighorn Lake would be the same as alternative A. Additional management strategies in alternative B would not affect the number of PWC using the reservoir in 2002 and 2012. Therefore, the emission levels and impacts of continued PWC use to air quality related values would be negligible adverse.

Cumulative Impacts. Cumulative adverse impacts to air quality related values at Bighorn Canyon National Recreation Area in both 2002 and 2012 would be negligible, as described under alternative A because additional PWC management strategies would not affect the volume of combined PWC and boating use in 2002 or 2012.

Conclusion. The impacts of alternative B would be the same as alternative A because additional PWC management strategies would not affect personal watercraft emissions. Alternative B would have negligible adverse impacts to air quality related values from PWC and from cumulative emissions of PWC and motorized boats in both 2002 and 2012. This conclusion is based on calculated levels of pollutant emissions and the low SUM06 values. There are no observed visibility impacts or ozone-related plant injury in the recreation area.

Implementation of this alternative would not result in an impairment of air quality related values.

Impacts of the No-Action Alternative: Allow No PWC Use

Analysis. Under the no-action alternative, PWC use within Bighorn Canyon National Recreation Area would not be reinstated. PWC emissions would be eliminated resulting in beneficial impacts to air quality related values.

Cumulative Impacts. Although PWC would be eliminated, other motorized watercraft would operate at the use levels described in the "PWC and Boating Use Trends" section. Cumulative impacts to air quality related values are shown in table 28. Overall emissions would be reduced compared to the other alternatives due to elimination of PWC. Cumulative adverse impacts to air quality related values would be negligible as in alternatives A and B due to levels of pollutant emissions, which would be less than 50 tons per year in 2002 and 2012, the SUM06 index values, and the lack of observable visibility impacts or ozone injury on plants.

Conclusion. HC, NO_x, and $PM_{2.5}$ emissions would be reduced due to a continued ban on PWC use resulting in negligible impacts to air quality related values from non-PWC watercraft in both 2002 and 2012. This conclusion is based on regional SUM06 values, the lack of existing or anticipated local ozone or visibility effects, and the calculated pollutant emission levels.

Implementation of this alternative would not result in an impairment of air quality related values.

SOUNDSCAPES

The primary soundscape issue relative to PWC use is that other visitors may perceive the sound made by personal watercraft as an intrusion or nuisance, thereby disrupting their experiences. This disruption is generally short term because personal watercraft travel along the shore to outlying areas. However, as PWC use increases and concentrates at beach areas, related noise becomes more of an issue, particularly during certain times of the day. Additionally, visitor sensitivity to PWC noise varies from fisherman (more sensitive) to swimmers at popular beaches (less sensitive).

TABLE 28: AIR QUALITY RELATED IMPACTS FROM MOTORIZED BOAT EMISSIONS AT BIGHORN CANYON, NO-ACTION ALTERNATIVE

Emissions (tons/year)						Visibility Observations and Forecast		Impact Level	
HC		NO_x		$PM_{2.5}$					
2002	2012	2002	2012	2002	2012	2002	2012	2002	2012
16	9	0.8	1.4	1.0	0.7	No perceptible visibility impacts	No perceptible visibility impacts	Negligible	Negligible
				Local Ozone Effects		SUM06 Index Value			
Ozone injury to plants (injury symptoms and monitoring data)				No park specific effects documented	No park specific effects anticipated	6–12 ppm-hrs (rural monitoring)	6–12 ppm-hrs (rural monitoring) Assumed to be no greater than in 2002		

Source for SUM06 values: NPS Air Quality Division year 2000 monitoring data.

GUIDING REGULATIONS AND POLICIES

The national park system includes some of the quietest places on earth as well as a rich variety of sounds intrinsic to park environments. These intrinsic sounds are recognized and valued as a park resource in keeping with the NPS mission (*Management Policies* [NPS 2000c, sec. 1.4.6]), and are referred to as the national recreation area's natural soundscape. The natural soundscape, sometimes called natural quiet, is the aggregate of all the natural sounds that occur in parks, absent human-caused sound, together with the physical capacity for transmitting the natural sounds (NPS *Management Policies* [NPS 2000c, sec. 4.9]). It includes all of the sounds of nature, including such "non-quiet" sounds as birds calling, waterfalls, thunder, and waves breaking against the shore. Some natural sounds are also part of the biological or other physical resource components of parks (e.g., animal communication, sounds produced by physical processes such as wind in trees, thunder, running water).

NPS policy requires the restoration of degraded soundscapes to the natural condition whenever possible, and the protection of natural soundscapes from degradation due to noise (undesirable human-caused sound) (NPS *Management Policies* [NPS 2000c, sec. 4.9]). The National Park Service is specifically directed to "take action to prevent or minimize all noise that, through frequency, magnitude, or duration, adversely affects the natural soundscape or other park resources or values, or that exceeds levels that have been identified as being acceptable to, or appropriate for, visitor uses at the sites being monitored" (NPS *Management Policies* [NPS 2000c, sec. 4.9]). Overriding all of this is the fundamental purpose of the national park system, established in law (e.g., 16 USC 1 et seq.), which is to conserve park resources and values (NPS *Management Policies* [NPS 2000c, sec. 1.4.3]). NPS managers must always seek ways to avoid, or to minimize to the greatest degree practicable, adverse impacts on park resources and values (NPS *Management Policies* [NPS 2000c, sec 1.4.3]).

Noise can adversely affect park resources, by modifying or intruding upon the natural soundscape. Noise can indirectly impact resources, for example by interfering with sounds important for animal communication, navigation, mating, nurturing, predation, and foraging functions. Noise impacts to non-human species are discussed in the "Threatened, Endangered, and Special Concern Species" section of this environmental assessment.

Noise can also adversely impact park visitor experiences. The term "visitor experience" can be defined as the opportunity for visitors to experience a park's resources and values in a manner appropriate to the national recreation area's purpose and significance, and appropriate to the resource protection goals for a specific area or management zone within that park. In other words, visitor experience is primarily a resource-based opportunity appropriate to a given park or area within a park, rather than a visitor-based desire. Noise impacts to visitor experience can be especially adverse when management objectives for visitor experience include solitude, serenity, tranquility, contemplation, or a completely natural or historical environment. Management objectives for resource protection and visitor experience are derived through well-established public planning processes from law, policy, regulations, and management direction applicable to the entire national park system and to each specific park unit.

Visitor uses of parks will only be allowed if they are appropriate to the purpose for which a park was established, and if they can be sustained without causing unacceptable impacts to park resources or values (NPS *Management Policies* [NPS 2000c, sec. 8.1 and 8.2]). While the fundamental purpose of all parks also includes providing for the "enjoyment" of park resources and values by the people of the United States, enjoyment can only be provided in ways that leave the resources and values unimpaired for the enjoyment of future generations (NPS *Management Policies* [NPS 2000c, sec. 1.4.3]). Unless mandated by statute, the National Park Service will not allow visitors to conduct activities that unreasonably interfere with "the atmosphere of peace and tranquility, or the natural soundscape maintained in wilderness and natural, historic, or commemorative locations within the park" (NPS *Management Policies*

[NPS 2000c, sec. 8.2]). While many visitor activities are allowed or even encouraged in parks consistent with the above policies, virtually all visitor activities are limited or restricted in some way (e.g., through carrying capacity determinations, implementation plans, or visitor use management plans), and on a park or area specific basis, some visitor activities are not allowed at all.

The degree to which a given activity (e.g., PWC use) is consistent with, or moves the condition of a resource or a visitor experience toward or away from a desired condition, is one measure of the impact of the activity.

The federal regulation pertaining to noise abatement for boating and water use activities (36 CFR 3.7, current draft) prohibits operating a vessel on inland waters "so as to exceed a noise level of 82 decibels measured at a distance of 82 feet (25 meters) from the vessel" and specifies that testing procedures to determine such noise levels should be in accordance with or exceed those established by the Society of Automotive Engineers (SAE) in "Exterior Sound Level Measurement Procedure for Pleasure Motorboats" (J34). This SAE procedure specifies that sound level measurements be taken 25 meters perpendicular to the line of travel of the vessel at full throttle (SAE 2001). It is important to note that this NPS regulation and the SAE procedure were developed for enforcement purposes, not impact assessment purposes. The noise level in the regulation does not imply that there are no impacts to park resources or visitor experiences when watercraft noise is within the regulatory limits; it just indicates that noise levels from vessels legally operating on NPS waters will be no "louder" than 82 dBA at 25 meters distance. As explained elsewhere in this document, a single decibel value does not provide much information for impact assessment purposes.

In addition to NPS policies, the States of Montana and Wyoming have adopted legislation that regulates PWC operation. The following elements of Montana PWC regulations may impact recreation area soundscapes (MFWP 2003):

- PWC must travel at "no wake" speed when operating on a lake within 100 feet or on a river within 50 feet of a dock, swimming raft, non-motorized boat, or anchored vessel.

- Decibels of a vessel may be no more than 86 dBA at 50 feet.

The following element of Wyoming PWC regulations may impact recreation area soundscapes (WGFD 2003).

No person operating a personal watercraft shall cross or jump the wake of another watercraft when within 100 feet of the watercraft creating the wake.

METHODOLOGY AND ASSUMPTIONS

The methodology used to assess PWC-related noise impacts in this document is consistent with NPS *Management Policies* (NPS 2000c)*, Director's Order #47: Soundscape Preservation and Noise Management,* and the methodology being developed for the reference manual for DO #47 (NPS 2000b). Specific factors at Bighorn Canyon National Recreation Area related to context, time, and intensity are discussed below and are then integrated into a discussion of the impact thresholds used in this analysis.

> **Context:** Existing background noise levels at Bighorn Canyon are influenced by wave action, wind, visitor activities, and watercraft. The lake area is too small for high speed use by any watercraft; therefore, fishing/trolling is the primary boating activity. Natural sounds are evident away from the marinas throughout most of the national recreation area. However, any noise is reflected off the sheer cliffs.

Time Factors: *Time Periods of Interest* — PWC use at Bighorn Canyon occurs primarily from June through August. On a daily basis, PWC use peaks during mid-day and generally stops during periods of inclement weather (e.g., cold, and thunderstorms).

Time periods of greater sensitivity to noise impacts include sunset, sunrise, and night time when visitors may be in camp and when wildlife may be more active.

Duration and Frequency of Occurrence of Noise Impacts — In areas of concentrated PWC use, noise from personal watercraft (and other boat types) can be present intermittently from early morning to sunset. In areas of lower use, noise from personal watercraft (and other boat types) can be occasional, usually lasting a few minutes.

Intensity: *Individual watercraft noise* — Personal watercraft-generated noise varies from vessel to vessel. The National Park Service contracted for noise measurements of personal watercraft and other motorized vessels in 2001 at Glen Canyon National Recreation Area (Harris et al. 2002). The results show that maximum personal watercraft noise levels at 25 meters (82 feet) ranged between 68 to 76 dBA on the A-weighted scale. Noise levels for other motorboat types measured during that study ranged from 65 to 86 decibels at 25 meters (82 feet). Visitors 100 feet from a personal watercraft may be exposed to noise levels of approximately 66 to 74 dBA. Noise levels vary with speed for most watercraft, with lower noise levels at lower speed. The severity of impact may also be affected by variations in noise levels that result from rapid changes in acceleration or direction.

Number of Active Watercraft — During the peak PWC use months of June through August, an average of 5 PWC use the lake each day, along with approximately 60 to 75 motorboats.

Context, time, and intensity together determine the level of impact for an activity. For example, noise for a certain period and intensity would be a greater impact in a highly sensitive context, and a given intensity would be a greater impact if it occurred more often or for longer duration. It is usually necessary to evaluate all three factors together to determine the level of noise impact. In some cases an analysis of one or more factors may indicate one impact level, while an analysis of another factor may indicate a different impact level, according to the criteria below. In such cases, best professional judgment based on a documented rationale must be used to determine which impact level best applies to the situation being evaluated.

PWC noise travels in relationship to the speed of the craft, the distance from shoreline, and other influences. To estimate the relative impacts of PWC use, the following methodology was applied:

1. Data from the 2001 watercraft noise study at Glen Canyon National Recreation Area was used to estimate the average decibel levels of personal watercraft.

2. Areas of shoreline use by other visitors were identified in relation to where personal watercraft launch and operate offshore. Personal observation from park staff and monthly use reports were used to identify these areas as well as determine the number of personal watercraft and timeframes of use.

3. Other considerations, such as topography and prevailing winds, were then used to identify areas where PWC noise levels could be exacerbated or minimized.

Sound levels generated by motorized craft using the recreation area are expected to affect recreational users differently. For example, visitors participating in less sound-intrusive activities such as camping would likely be more adversely affected by PWC noise than another PWC or motorboat user. Therefore,

impacts to soundscape must take into account the effect of noise levels on different types of recreational users within the impact analysis area. The following is a list of other considerations for evaluating sound impacts:

1. The number of PWC and non-PWC watercraft per day on a typical summer day in the national recreation area was assumed from table 13 presented in the "PWC and Boating Use Trends" section.

2. Personal watercraft commonly operate farther than 150 feet from the shoreline; the farther from shore, the lower the noise level to shoreline visitors.

3. Noise levels within flat-wake zones are less than at full throttle and occur for short durations.

4. At Bighorn Canyon, most of the non-PWC watercraft do not operate at full throttle or high speed. This reflects both the limited areas for maneuvering as well as the primary water-based use, fishing.

5. Ambient noise levels at most locations include wind, waves, occasional automobiles, other visitor activities, and other motorboats.

IMPACT ANALYSIS AREA

The impact analysis area for soundscapes is related to the area of PWC use and the distance that PWC noise travels. PWC are allowed to operate in locations on Bighorn Lake as indicated on the alternatives maps. For the existing condition, PWC operate in all areas except those identified in the alternatives presented the "Alternatives" chapter.

It is understood that at the time of preparation of this environmental analysis, the water levels in Bighorn Canyon are substantially lower than normal, and that watercraft operation can not occur in many areas that may be described. However, for purposes of a conservative impact analysis, it is assumed that watercraft would operate in all accessible and permitted areas that would exist during normal and above normal water years.

PWC noise is reduced over distance. Compared to the noise level at a distance of 50 feet, a reduction of approximately 34 dBA would be expected over a distance of 0.75 mile, with the noise from a single PWC reduced to 34–42 dBA, which is less than daytime ambient noise levels in the more populated recreation areas. Noise levels would be greater with multiple watercraft or where noise may be reflected off canyon walls. Thus, the impact analysis area for soundscapes will be taken as the lake area, shoreline, and the 0.75-mile inland shore area.

IMPACT TO VISITORS FROM NOISE GENERATED BY PERSONAL WATERCRAFT

After estimating the number of personal watercraft, the range of relative noise generated by PWC, and the potential areas where noise concentrations and effects on other visitors may be of concern, the following thresholds were used as indicators of the magnitude of impact for each of the PWC management alternatives:

Negligible: Natural sounds would prevail; motorized noise would be very infrequent or absent, mostly immeasurable.

Minor: Natural sounds would predominate in areas where management objectives call for natural processes to predominate, with motorized noise infrequent at low levels. In areas where motorized noise is consistent with park purpose and objectives, motorized noise could be heard frequently throughout the day at moderate levels, or infrequently at higher levels, and natural sounds could be heard occasionally.

Moderate: In areas where management objectives call for natural processes to predominate, natural sounds would predominate, but motorized noise could occasionally be present at low to moderate levels. In areas where motorized noise is consistent with park purpose and objectives, motorized noise would predominate during daylight hours and would not be overly disruptive to noise-sensitive visitor activities in the area; in such areas, natural sounds could still be heard occasionally.

Major: In areas where management objectives call for natural processes to predominate, natural sounds would be impacted by human noise sources frequently or for extended periods of time at moderate intensity levels (but no more than occasionally at high levels), and in a minority of the area. In areas where motorized noise is consistent with park purpose and zoning, the natural soundscape would be impacted most of the day by motorized noise at low to moderate intensity levels, or more than occasionally at high levels; motorized noise would disrupt conversation for long periods of time and/or make enjoyment of other activities in the area difficult; natural sounds would rarely be heard during the day.

Impairment: The level of noise associated with PWC use would be heard consistently and would be readily perceived by other visitors throughout the day, especially in areas where such noise would potentially conflict with the intended use of that area. In addition, these adverse, major impacts to park resources and values would contribute to deterioration of the park's soundscape to the extent that the park's purpose could not be fulfilled as established in its enabling legislation; affect resources key to the park's natural or cultural integrity or opportunities for enjoyment; or affect the resource whose conservation is identified as a goal in the park's general management plan or other park planning documents.

Impacts of Alternative A — Reinstate PWC Use under a Special Regulation as Previously Managed

Analysis. Under alternative A, PWC use would be reinstated in Bighorn Canyon, as it was managed prior to closure to PWC. As stated in the assumptions, PWC use levels on Bighorn Lake would range from 5 craft per day during the typical peak use season, increasing to 6 per day over the next 10 years. PWC are generally found around OK-A-Beh Marina and Horseshoe Marina. The distribution and regulation of PWC under this alternative would continue the same pattern of use that existed prior to closure.

Historically, PWC use patterns in Bighorn Canyon are characterized by several people per PWC who take turns riding. Personal watercraft will return to the area where a group is picnicking/camping to rest or switch riders. From park staff observations, personal watercraft generally run at higher speeds (and higher noise levels) leaving the launch or picnic/camping areas and when personal watercraft are in open water. While in the Montana jurisdictional area, PWC users must travel at "no wake" speed when operating on a lake within 100 feet of a drifting, trolling or anchored watercraft or persons in the water, or on a river within 50 feet of a dock, swimming raft, non-motorized boat, or anchored vessel. However, there are picnic and other shoreline use areas where PWC can operate closer to shore, if no swimmers are present. Users at the picnic areas or swimming areas at those locations are exposed to PWC noise as they come in and out of the shore area if allowed, and from noise of several PWC that may be operating at high speeds in the vicinity. Currently, no Montana or Wyoming laws restrict PWC speed. The noise impact from a PWC coming into the shore area is dependent on the distance from shore that the operator slows down

and at what speed they approach the shoreline. One PWC operating at 50 feet from shore at 40 mph would generate noise levels of approximately 78 dBA to a shoreline observer; at 20 mph, the noise level would be approximately 73 dBA. At a distance of 100 feet, the noise level would be approximately 6 dBA less than at a distance of 50 feet. The noise level from two identical watercraft would be 3 dBA higher than from a single vessel. With new designs of personal watercraft, engines may be quieter in the future.

Overall, noise from personal watercraft would be expected to have short-term, minor to moderate adverse impacts at certain locations along the lake on days of heavy PWC use. Minor adverse impacts would occur at times and places where use is infrequent and distanced from other park users, for example, as PWC users operated far from shore. Moderate adverse impacts would occur at landings on the lake on days of relatively consistent PWC operation with more than one PWC operating at one time. Moderate adverse impacts would occur from highly concentrated PWC use in one area and in areas where PWC noise is magnified by reflection off the surrounding cliffs. Most visitors expect to hear motorized noise from fishing and sightseeing boats operating at low speeds, but not from personal watercraft. Moreover, moderate adverse impacts would also occur if PWC users choose to operate in areas of the national recreation area that are away from launch areas and campgrounds, and where shoreline visitors would be anticipating a quiet, wilderness experience. However, as noted in the "Affected Environment" chapter, park staff have not received noise complaints about personal watercraft.

Cumulative Impacts. Non-PWC noise sources in Bighorn Canyon include natural sounds such as waves or wind, other boats, and other visitor activities. Motorboats account for approximately 96% of all watercraft use on Bighorn Lake, and although motorboats can generate similar maximum sound levels as PWC, the motorboats are generally not perceived to be as annoying due to their more typical steady rate of speed and direction. Also, at Bighorn Lake, most motorboats are driven at slow speeds for fishing/trolling or sightseeing and create relatively low noise levels.

Cumulative adverse impacts on the Bighorn Canyon soundscape from PWC, boating, and other noise sources would be predominately moderate in the summer months. The cumulative impacts would be more severe than from PWC alone because there are many more total watercraft than PWC. It is not anticipated that the noise would be so great as to make enjoyment of other activities difficult. Impacts would generally be long-term because of the volume of boating use distributed throughout much of the year and because the use reoccurs annually. In areas where management objectives call for natural processes to predominate, impacts would be minor only in the winter months, with moderate impacts during the remainder of the year.

Other visitors would also contribute to the soundscape, including beach users, picnickers, and campers. However, these sounds are considered more acceptable and compatible with typical uses within the national recreation area. Visitor noise, in combination with PWC activity, would have a negligible adverse effect on the soundscape at Bighorn Canyon. Impacts would be short term, since noise would usually be present for limited duration.

Conclusion. Noise from PWC would have minor to moderate adverse impacts over the short and long-term at most locations on Bighorn Lake and immediate surrounding area. Impacts would be related to the number of personal watercraft operating as well as the sensitivity of other visitors.

Cumulative noise impacts from personal watercraft, motorboats, and other visitors would be minor to moderate adverse impacts over the short and long-term because these sounds would be heard occasionally throughout the day, and may predominate on busy days during the high use season.

Implementation of this alternative would not result in an impairment of soundscape values.

Impacts of Alternative B — Reinstate PWC Use under a Special Regulation with Additional Management Prescriptions

Analysis. Under alternative B, PWC use would be reinstated with additional management prescriptions. Specifically, PWC would not be allowed south of the area known as the South Narrows. The geographic restriction of alternative B would result in the elimination of PWC noise experienced by park visitors in the areas south of the South Narrows, including fisherman and shoreline and near shoreline users of the swimming, picnic, and camping areas. Because PWC use is already limited in this area, beneficial impacts from a reduction of PWC noise would be negligible.

Overall, the types and levels of adverse impacts from PWC to the soundscape north of the South Narrows would be generally the same as for alternative A, which would include short-term, minor to moderate adverse impacts at certain locations along the lake on days of heavy PWC use. Minor adverse impacts would occur at times and places where use is infrequent and distanced from other park users, for example, as PWC users operated far from shore. Moderate adverse impacts would occur at landings on the lake on days of relatively consistent PWC operation with more than one PWC operating at one time. Moderate adverse impacts would occur from highly concentrated PWC use in one area and in areas where PWC noise is magnified off the surrounding cliffs.

Impacts would generally be short-term, although could periodically be longer-term at shoreline areas on the very high use days, where motorized noise may predominate off and on for most of the day. Bighorn Canyon is known by the mostly local and regional users for providing extensive fishing as well as other recreational opportunities.

Cumulative Impacts. Non-PWC noise sources in Bighorn Canyon include natural sounds such as waves or wind, other boats, and other visitor activities. Motorboats account for approximately 96% of all watercraft use on Bighorn Lake. Although some motorboats can generate maximum sound levels similar to PWC, the motorboats are generally not perceived to be as annoying due to their more typical steady rate of speed and direction. Further, at Bighorn Canyon, most are driven at slow speeds for fishing/trolling or sightseeing and create relatively low noise levels.

The geographic restriction of alternative B would slightly reduce cumulative noise impacts south of the South Narrows area compared to alternative A because PWC use is limited in this area due to low water levels.

Cumulative impacts in the area south of the South Narrows would be minor. In the remainder of the national recreation area, impacts would be similar to those of alternative A, which would be predominately moderate in the summer months. In areas where management objectives call for natural processes to predominate, impacts may be minor only in the winter months, with moderate impacts during the remainder of the year.

Conclusion. Alternative B would result in a negligible to moderate adverse impact on the national recreation area soundscape. PWC impacts would be negligible south of the South Narrows due to geographic restriction of PWC in this area. Minor and moderate PWC noise impacts would occur in the areas of the national recreation area north of the South Narrows. Impacts would generally be short-term, although could periodically be longer-term at shoreline areas on the very high use days, where motorized noise may predominate off and on for most of the day.

Cumulative noise impacts from personal watercraft, motorboats, and other visitors would be minor to moderate because these sounds would be heard occasionally throughout the day, and may predominate on busy days during the high use season.

Implementation of this alternative would not result in an impairment of soundscape values.

Impacts of the No-Action Alternative: Allow No PWC Use

Analysis. Under the no-action alternative PWC use would not be reinstated. Therefore, no impact to the national recreation area soundscape would result from PWC operations resulting in a beneficial impact.

Cumulative Impacts. Cumulative impacts would be similar to, but slightly less than, alternatives A and B since other motorized boating activities would continue to create noise impacts throughout the day and in many locations of the lake. Though PWC use is a small percentage (approximately 4%) of motorized watercraft use, the elimination of PWC would have a beneficial effect to the cumulative impacts to the soundscape on and near the lake. Cumulative impacts would be minor to occasionally moderate adverse.

Other uses also contribute to the area's soundscape, including swimming, picnicking, and camping. However, these sounds are considered more acceptable and compatible with other uses. Visitor noise has a negligible adverse effect on the natural soundscape at the national recreation area.

Conclusion. The continued ban on PWC would result in a decrease in noise experienced at the national recreation area. Contributions of PWC to cumulative impacts would be eliminated. Cumulative noise impacts from other motorized watercraft and other visitor activities would be the same as in alternatives A and B. Cumulative impact would continue to be minor to moderate adverse in the short and long-term.

This alternative would not result in an impairment of soundscape values.

WILDLIFE AND WILDLIFE HABITAT

Some research suggests that PWC use affects wildlife by causing interruption of normal activities, alarm or flight, avoidance or degradation of habitat, and effects on reproductive success. This is thought to be a result of a combination of PWC speed, noise, and ability to access sensitive areas, especially in shallow-water depths.

Waterfowl and nesting birds are the most vulnerable to personal watercraft. Fleeing a disturbance created by personal watercraft may force birds to abandon eggs during crucial embryo development stages, prevent nest defense from predators, or contribute to stress and associated behavior changes.

Impacts to sensitive species, such as the bald eagle, are documented under "Threatened, Endangered, or Special Concern Species."

GUIDING REGULATIONS AND POLICIES

The NPS *Organic Act*, which directs parks to conserve wildlife unimpaired for future generations, is interpreted by the agency to mean that native animal life should be protected and perpetuated as part of the national recreation area's natural ecosystem. Natural processes are relied on to control populations of native species to the greatest extent possible; otherwise they are protected from harvest, harassment, or harm by human activities. According to NPS *Management Policies 2001,* the restoration of native species is a high priority (sec. 4.1). Management goals for wildlife include maintaining components and processes of naturally evolving national recreation area ecosystems, including natural abundance, diversity, and the ecological integrity of plants and animals.

The Yellowtail Wildlife Habitat area is located at the southern end of Bighorn Canyon and is managed by the Wyoming Game and Fish Department. One-third of the Pryor Mountain Wild Horse Range overlaps with the Bighorn Canyon National Recreation Area on the west-central border of the national recreation area and the wild horse range is managed by the BLM. There are no other additional federal, state, or local regulations or policies for wildlife and wildlife habitat at Bighorn Canyon National Recreation Area.

METHODOLOGY AND ASSUMPTIONS

Potential impacts to wildlife and wildlife habitat were evaluated based on the pattern of PWC use in Bighorn Canyon, the nature of habitats and species present, and the professional judgment of the project team and members of the national recreation area staff. Information on wildlife habitat was acquired from national recreation area staff, existing NPS reports, USFWS, Wyoming Game and Fish Department, Montana Fish, Wildlife, and Parks Department, and other public information resources. To assess impacts from PWC use on wildlife, the following assumptions were made:

1. The majority of PWC users operate their craft in a lawful manner.

2. Approximately five personal watercraft are on Bighorn Canyon during a peak summer day such as the 4th of July for an average of 2 hours per day.

3. Generally, impacts are expected to be similar or slightly greater in 2012 relative to 2002 due to the slight increase in PWC use at Bighorn Canyon of 1% per year. Approximately six personal watercraft would be on the water in 2012 on a peak use day.

4. PWC users who disembark on the shore would travel no more than 100 feet inland and would follow existing trails.

IMPACT ANALYSIS AREA

The impact analysis area for wildlife and wildlife habitat is Bighorn Lake and the surrounding shoreline area, extending inland to approximately 200 feet. This 200-foot inland segment is assumed to provide a more encompassing range of assessment, based on the distance of PWC operation from the shoreline, wildlife responses to PWC activity, and the likely distance PWC users would travel inland.

IMPACT OF PWC USE AND NOISE ON WILDLIFE AND HABITAT

The following thresholds were used to determine the magnitude of effects on wildlife and wildlife habitat:

Negligible: No wildlife species are present; no impacts or impacts with only temporary effects are expected.

Minor: Non-breeding animals are present, but only in low numbers. Habitat is not critical for survival; other habitat is available nearby. Occasional flight responses by wildlife are expected, but without interference with feeding, reproduction, or other activities necessary for survival.

Moderate: Breeding animals are present; animals are present during particularly vulnerable life-stages such as migration or juvenile stages; mortality or interference with activities

necessary for survival are expected on an occasional basis, but are not expected to threaten the continued existence of the species in the park.

Major: Breeding animals are present in relatively high numbers, and/or wildlife are present during particularly vulnerable life stages. Habitat targeted by PWC use or other actions has a history of use by wildlife during critical periods and is somewhat limited. Mortality or other effects are expected on a regular basis and could threaten the continued survival of the species in the park.

Impairment: Some of the major impacts described above might be an impairment of national recreation area resources if their severity, duration, and timing resulted in the elimination of a native species or significant population declines in a native species. In addition, these adverse, major impacts to national recreation area resources and values would:

- Contribute to deterioration of the park's wildlife resources and values to the extent that the park's purpose could not be fulfilled as established in its authorizing legislation;
- Affect resources key to the park's natural or cultural integrity or opportunities for enjoyment; or
- Affect the resource whose conservation is identified as a goal in the park's general management plan or other park national recreation area planning documents.

Impacts of Alternative A — Reinstate PWC Use under a Special Regulation as Previously Managed

Analysis. PWC use could affect wildlife wherever motorized vessels are allowed. Restrictions that were in place prior to the PWC closure as described in the "Alternatives" chapter would be applicable. Due to low water and air temperatures throughout the majority of the year, primary PWC use occurs from June through September. PWC use levels are low relative to other recreation area activities, with approximately five PWC users on a peak use summer day in 2002, as noted in the "Methodology and Assumptions" section. PWC would be allowed to launch from sites located at Ok-A-Beh and Horseshoe Bend marinas and Barry's Landing. Ok-A-Beh Marina is the primary area of PWC use in the recreation area. Depending on water levels, use may also occur at Horseshoe Bend and Barry's Landing.

PWC use does not generally occur within the canyon areas due to lack of landing areas and rough waters. Accessible shoreline areas along Bighorn Lake for PWC users and other visitors are limited due to steep canyon walls and fluctuations in water levels associated with reservoir operations and drought cycles. Shoreline access is primarily limited to developed launch sites and campgrounds.

Suitable shoreline habitat is limited for most species due to steep canyon walls present throughout the majority of the national recreation area. Primary habitat for many species is associated with tributary drainages or riparian forest areas in the Yellowtail Wildlife Habitat area. There are no documented cases of deliberate harassment or collisions with wildlife by PWC users on Bighorn Lake.

The following summarizes the impacts that would be expected from PWC use to the wildlife species and habitat discussed in the "Affected Environment" chapter. In some cases, species mentioned in the general wildlife description are not likely to occur in the limited area of water and shoreline that is within the area of PWC use and therefore are not included in the impact analysis.

Mammals — Impacts to mammals would be negligible to minor as most species rarely use the available shoreline. Most mammals are either transient visitors from inland parts of the recreation area or are generally acclimated to human intrusion. In general, aquatic mammals such as beaver are mobile and can avoid noise and physical disturbance associated with PWC use. Their breeding areas are typically in backwater areas not frequented by personal watercraft and adverse impacts would be negligible. Other small mammals common to the area such as marmots, skunks, and porcupines generally acclimate easily to human activity and have the ability to avoid impacts, but PWC would potentially cause minor impacts due to noise and disturbance. Larger mammals such as black bear and mountain lion are transient visitors to the recreation area and impacts from PWC would likely be negligible.

Primary habitat for wild horses is located in the Pryor Mountain Wild Horse Range where the horses have protected status. This range is located partly within the national recreation area adjacent to the west side of steep canyon areas where PWC use does not typically occur. Negligible adverse impacts would potentially result from PWC noise disturbance to horses when accessing shoreline areas outside of the protected Pryor Mountain Wild Horse Range.

Primary habitat for white-tailed and mule deer within the national recreation area is located in the Yellowtail Wildlife Habitat area. PWC occasionally frequent this area when water levels are suitable for PWC use, and negligible adverse impacts to these species would include disturbance from PWC noise when this occurs.

Birds — Breeding habitat (aquatic and shoreline vegetation) for birds is lacking within most areas utilized by personal watercraft at Bighorn Lake. Valuable habitat is located in the riparian woodlands and wetlands of the Yellowtail Wildlife Habitat area, but PWC use in this portion of the national recreation area is infrequent. Afterbay Lake also contains some suitable waterfowl habitat but this area would be closed to PWC access under this alternative. Most personal watercraft are not used during the spring months at Bighorn Lake due to low water and air temperatures, minimizing the potential for disturbance to breeding individuals. Waterfowl would be more susceptible to PWC use than other bird species, but any impacts would be short-term, and would likely constitute temporary disturbance to foraging or resting individuals through noise or physical disturbance. The potential exists for some impacts during brood rearing in the Yellowtail Wildlife Habitat area, but is unlikely due the infrequent PWC use in this area. Overall, due to a lack of breeding or brood rearing habitat for waterfowl and other birds in areas of PWC use at Bighorn Lake, adverse impacts to avian species and associated habitat would be short-term, negligible to minor.

Fish — PWC use could potentially affect fish through pollutant loads and/or physical disturbance. As discussed in the "Water Quality" section of this chapter, reinstated use of PWC would create pollutant loads that are well below ecotoxicological benchmarks. Therefore, adverse impacts to fish related to water contamination by PWC use at Bighorn Lake would be negligible. Impacts from pollution would decrease between 2002 and 2012, despite projected increases in PWC use, because overall pollutant loads would decrease as a result of marine engine conversions to cleaner engine technology per EPA industry standards.

The limited amount of shoreline aquatic vegetation and invertebrate populations in areas of PWC use in Bighorn Lake precludes the existence of concentrated shallow water feeding areas that would be susceptible to effects from PWC. In general, fish avoid direct impact from PWC. Adverse impacts from physical disturbance by PWC use to fish populations and spawning areas at Bighorn Lake would be short-term, negligible to minor.

Amphibians and Reptiles — Impacts to reptiles and amphibians would be most likely to occur in locations where PWC or their users disrupt nesting or breeding sites. Such sites are not known to be common in

areas of PWC use in Bighorn Lake. Adverse impacts from PWC activity would be negligible and are expected to be short term.

Cumulative Impacts. Potential cumulative impacts to wildlife and wildlife habitat in the recreation area include various visitor activities, such as other watercraft operation, that occur in proximity to wildlife species. Reservoir operations are also a potential source of cumulative impacts. Due to the sheer cliffs in the majority of the recreation area, visitors mainly have access to the shoreline by watercraft at developed facilities, though some hiking and hiking-accessed camping activities also occur, mainly in the area around Barry's Landing. Non-PWC boating activities account for approximately 96% of total boating activity in the recreation area. Wildlife routinely exhibit movement or flight response due to disturbance by powerboats that is similar to response from PWC-caused disturbance (Rodgers and Schwikert 2002).

Interactions between wildlife and human visitors would be limited because of the low abundance of wildlife within the PWC use areas and the lack of shoreline access. Shoreline activities would be concentrated around visitor facilities, where habitat characteristics are lacking due to prior development and ongoing activity levels. Visitor interactions would not interfere with feeding, reproduction, or other activities necessary for the survival of wildlife species. Cumulatively, visitors engaging in multiple activities, including PWC use, would cause minor to moderate, short-term, adverse impacts to wildlife.

Bighorn Lake operates with a common pattern in most years. Water is released from Yellowtail Dam in the fall and winter, allowing the reservoir to fill in the spring and early summer from snowmelt runoff. Maximum water elevation is normally seen in the late summer and minimum water elevation occurs during the early spring. This operation pattern results in minimal changes to the surface area of the lake at the north end because of steep canyon walls; however, surface area in the south end of the lake changes dramatically within the operation cycle. When lake levels are high, large shallow areas along the Bighorn and Shoshone Rivers can be inundated, and, conversely, when lake levels are low these areas are dry. Many times launch facilities in the Horseshoe Bend area can be rendered unusable because the water level is well below the elevation of the launch facilities

Fluctuation of lake levels related to lake operations and drought cycles, sediment accumulation, floating driftwood, and high water temperatures contribute to cumulative effects on fish in the national recreation area (Jacobs et al. 1996). Wildlife habitat is also potentially affected when lake fluctuations affect water levels in tributary drainages that support wetland and riparian vegetation. Adverse impacts to fish or wildlife habitat from lake operations in combination with PWC and boating activity could be minor to moderate, and short to long term.

Conclusion. PWC use would have negligible to minor adverse impacts on fish, waterfowl, and other wildlife. There would be no perceptible changes in wildlife populations or their habitat community structure. Due to low levels of PWC use in the recreation area, coupled with a lack of habitat in areas of frequent PWC use, any impacts to fish, wildlife and respective habitats would be temporary and short term. The intensity and duration of impacts is not expected to increase substantially over the next 10 years, since PWC numbers would not increase substantially and engine technology would continue to improve under EPA industry regulations. Cumulative impacts from visitor activities would have short-term, minor to moderate adverse effects on wildlife and wildlife habitat. Lake operations and drought cycles also contribute to cumulative impacts through fluctuations in water level and potentially would cause short to long-term minor to moderate adverse impacts to fish, and beneficial or adverse impacts to riparian and wetland areas that provide habitat for wildlife.

Implementation of this alternative would not result in impairment to wildlife or wildlife habitat.

Impacts of Alternative B — Reinstate PWC Use under a Special Regulation with Additional Management Prescriptions

Analysis. Under alternative B, PWC use would occur as under alternative A, with additional management prescriptions. Restrictions on PWC use would include a closure of the reservoir and shoreline south of the area known as the South Narrows. Buoys would be installed to delineate the boundary and PWC users would be required to stay north of this boundary. A user education program would also be implemented through vessel inspections, law enforcement contacts, and signing.

This alternative would result in some beneficial impacts to wildlife as increased user awareness and a decreased area of PWC activity would reduce the likelihood of user and wildlife conflicts. The additional restricted portion includes the Yellowtail Wildlife Habitat area, typically an area of infrequent PWC use due to low water levels, but with potential for use when water levels are sufficient. Adverse impacts to fish and wildlife from PWC use on Bighorn Lake would remain negligible to minor, but would be less than those predicted under alternative A. All wildlife impacts would be temporary and short term.

The establishment of a user education program would assist in lowering PWC accident frequency, as well as in increasing PWC user awareness of potential conflicts with wildlife. This would lead to a reduction in the potential for PWC-related effects to wildlife and wildlife habitat relative to alternative A.

Cumulative Impacts. The cumulative effects of alternative B would be the same as alternative A. Adverse impacts to wildlife and wildlife habitat from visitor activities including PWC and boating use would be short-term and minor to moderate. Lake operations and drought could cause short to long-term, minor to moderate adverse impacts to fish and wildlife habitat through effects on water level.

Conclusion. The reinstatement of PWC use with additional management prescriptions and education efforts would have beneficial impacts to wildlife due to the decreased noise and disturbance from PWC. Although reduced, impacts to wildlife and wildlife habitat from PWC use would remain adverse negligible to minor in 2002 and 2012, similar to alternative A. All wildlife impacts from personal watercraft would be temporary and short term. Cumulative adverse impacts from visitor activities would be minor to moderate as under alternative A. Lake level fluctuations would also contribute to cumulative adverse impacts through minor to moderate levels of short to long-term habitat disturbance.

Implementation of this alternative would not result in impairment to wildlife or wildlife habitat.

Impacts of the No-Action Alternative: Allow No PWC Use

Analysis. Under the no-action alternative, PWC use would not be reinstated. Potential impacts from PWC to wildlife and wildlife habitat, including the effects from physical disturbance, noise, or emissions would be eliminated. This alternative would result in beneficial impacts to the resource.

Cumulative Impacts. Cumulative impacts to wildlife would be similar to those described for alternatives A and B. The ban on PWC would not noticeably change the intensity of cumulative impacts due to low PWC use patterns in the national recreation area. Visitors using other watercraft, as well as those engaging in other activities, would have access to the shoreline and could cause temporary flight responses in wildlife. Cumulative adverse impacts to wildlife from visitor activities would be minor to moderate and short-term. Lake operations and drought would cause minor to moderate short to long-term adverse impacts to fish and wildlife habitat through lake level fluctuations.

Conclusion. PWC use would not be reinstated on Bighorn Lake, resulting in beneficial impacts to wildlife and wildlife habitat due to the reduction of interactions between PWC users and wildlife within

the national recreation area. Cumulative adverse impacts on wildlife and wildlife habitat would be short-term, minor to moderate due to visitor activities and short to long-term, minor to moderate from lake level fluctuations. The contribution of PWC use to overall adverse impacts to wildlife and wildlife habitat would be eliminated.

Implementation of this alternative would not result in impairment to wildlife or wildlife habitat.

THREATENED, ENDANGERED, OR SPECIAL CONCERN SPECIES

The same issues described for PWC use and general wildlife also pertain to special status species. Potential impacts from PWC include inducing flight and alarm responses, disrupting normal behaviors and causing stress, degrading habitat quality, and potentially affecting reproductive success. Special status species at the recreation area include federally listed threatened, endangered, or candidate species. Additionally, some species at Bighorn Lake are designated by Wyoming and/or Montana as special concern species.

GUIDING REGULATIONS AND POLICIES

The *Endangered Species Act* (16 USC 1531 et seq.) mandates that all federal agencies consider the potential effects of their actions on species federally listed as threatened or endangered. If the National Park Service determines that an action may adversely affect a federally listed species, consultation with the U.S. Fish and Wildlife Service is required to ensure that the action will not jeopardize the species' continued existence or result in the destruction or adverse modification of critical habitat.

An analysis of the potential impacts to those special status species that potentially could be affected by PWC use at Bighorn Lake is included in this section. At Bighorn Lake it has been determined that none of the alternatives are likely to adversely affect any of the listed species. The completed environmental assessment will be submitted to the U.S. Fish and Wildlife Service for its review. If the agency concurs with the finding of the National Park Service, no further consultation will be required.

Formal consultation would be initiated if the National Park Service determined that actions in the preferred alternative would be likely to adversely affect one or more of the federally listed threatened or endangered species identified in the recreation area. At that point a biological assessment would be prepared to document the potential effects. From the date of initiation of formal consultation, the Fish and Wildlife Service would be allowed 90 days to consult with the agency and 45 days to prepare a biological opinion based on the biological assessment and other scientific sources. The Fish and Wildlife Service would state its opinion as to whether the proposed PWC activities would be likely to jeopardize the continued existence of the listed species or to result in the destruction or adverse modification of critical habitat. Such an opinion would be the same as a determination of impairment. To ensure that a species would not be jeopardized by PWC activities, the National Park Service would confer with the Fish and Wildlife Service to identify recommendations for reducing adverse effects and would integrate those into the preferred alternative.

NPS *Management Policies 2001* states that potential effects of agency actions will also be considered regarding state or locally listed species. The National Park Service is required to control access to critical habitat of such species, and to perpetuate the natural distribution and abundance of these species and the ecosystems upon which they depend.

State and federally listed species were identified through discussions with national recreation area staff, and consultation of Wyoming Game and Fish, Montana Fish, Wildlife, and Parks, and U.S. Fish and Wildlife resources. A consultation informing the agency of the action was sent to the U.S. Fish and Wildlife Service.

METHODOLOGIES AND ASSUMPTIONS

Primary steps in assessing impacts on listed species were taken to determine the following:

1. Which species are found in areas likely to be affected by management actions described in the alternatives.

2. Current and future use and distribution of personal watercraft by alternative.

3. Habitat loss or alteration caused by the alternatives.

4. Displacement and disturbance potential of the actions and the species' potential to be affected by PWC activities.

The information in this analysis was obtained through best professional judgment of national recreation area staff and experts in the field (as cited in the text), and by conducting a literature review.

Basic assumptions were made regarding personal watercraft and visitor activities, as follows:

1. The majority of PWC users operate their craft in a lawful manner.

2. Approximately five PWC are on Bighorn Lake during a peak summer day for an average of 2 hours per day.

3. Generally, impacts are expected to be similar in 2012 relative to 2002 due to the slight increase in PWC use at Bighorn Lake of 1% per year. Approximately six PWC would be on the water in 2012 on a peak use day.

4. PWC users who disembark on the shore would travel no more than 100 feet inland and would follow existing trails.

The PWC and visitor use trends data were used to evaluate impacts to threatened or endangered species. Additional information was obtained from national recreation area staff. Vegetation and wildlife information was provided by Bighorn Canyon resource specialists, existing NPS reports, and literature reviews.

IMPACT ANALYSIS AREA

The impact analysis area for threatened, endangered, or special concern species is Bighorn Canyon and the surrounding shoreline area inland to approximately 200 feet. This 200-foot inland segment is assumed to provide a more encompassing range of assessment, based on the distance of PWC operation from the shoreline, wildlife responses to PWC activity, and the likely distance PWC users would travel inland.

IMPACT OF PWC USE ON SUCH SPECIES

The *Endangered Species Act* defines the terminology used to assess impacts to listed species as follows:

> *No effect:* When a proposed action would not affect a listed species or designated critical habitat.
>
> *May affect / not likely to adversely affect:* Effects on special status species are discountable (i.e., extremely unlikely to occur and not able to be meaningfully measured, detected, or evaluated) or are completely beneficial.
>
> *May affect / likely to adversely affect:* When an adverse effect to a listed species may occur as a direct or indirect result of proposed actions and the effect either is not discountable or is completely beneficial.
>
> *Is likely to jeopardize proposed species / adversely modify proposed critical habitat (impairment):* The appropriate conclusion when the National Park Service or the U.S. Fish and Wildlife Service identifies situations in which PWC use could jeopardize the continued existence of a proposed species or adversely modify critical habitat to a species within or outside national recreation area boundaries. This would be equivalent to impairment if the impact to listed species and their habitat would be affected to the point that the park's purpose (authorizing legislation, general management plan, and strategic plan) could not be fulfilled and resources could not be experienced and enjoyed by future generations.

Impacts of Alternative A — Reinstate PWC Use under a Special Regulation as Previously Managed

Analysis. PWC use could affect threatened, endangered or other special status wildlife wherever use occurs in close proximity to listed species or associated habitats. Restrictions that were in place prior to the PWC closure as described in the "Alternatives" chapter would be applicable. Due to low water and air temperatures throughout the majority of the year, primary PWC use occurs from June through September. PWC use levels are low relative to other recreation area activities, with approximately five PWC users on a peak use summer day in 2002, as noted in the "Methodology and Assumptions" section. PWC would be allowed to launch from sites located at Ok-A-Beh and Horseshoe Bend marinas and Barry's Landing. Ok-A-Beh Marina is the primary area of PWC use in the recreation area. Depending on water levels, use may also occur at Horseshoe Bend and Barry's Landing.

PWC use does not generally occur within the canyon areas due to lack of landing areas and rough waters. Accessible shoreline areas along Bighorn Lake for PWC users and other visitors are limited due to steep canyon walls and fluctuations in water levels associated with reservoir operations and drought cycles. Shoreline access is primarily limited to developed launch sites and campgrounds.

The following summarizes the impacts that would be expected from PWC use to the federal and state listed endangered, threatened and candidate species, and special concern species discussed under the "Affected Environment" chapter. In some cases, species previously mentioned in the "Affected Environment" chapter are not likely to occur in the limited area of water and shoreline that is within the area analyzed for impacts from PWC and other watercraft. Generally, impacts are expected to be similar in 2012 relative to 2002 due to the only slight increase of 1% per year in PWC use in the area.

SPECIAL STATUS ANIMALS

Bighorn Lake provides wintering habitat for bald eagles (federally listed threatened and Montana and Wyoming listed special concern species), as there is an ample food supply available within the waters of the area. The over-wintering population of eagles at Bighorn Lake is large and bald eagles nest along the Bighorn River south of the main reservoir. However, nesting areas are not within the range of PWC or boat noise. The number of resident eagles at the recreation area in recent years suggests that PWC use or other watercraft activities at Bighorn Lake is not a limiting factor for area populations. PWC use or other watercraft activities at Bighorn Lake may affect, but is not likely to adversely affect, bald eagles or their habitat.

The mountain plover is federally classified as a proposed threatened species, and as such is protected as a threatened species under the *Endangered Species Act*. The mountain plover has not been documented within the national recreation area, and there is no suitable habitat for the mountain plover within the area of PWC use. PWC use within the national recreation area is expected to have no effect on the mountain plover.

Two federal species of concern could potentially be affected by PWC use: the American peregrine falcon and the Rocky Mountain bighorn sheep. The American peregrine falcon has been observed in Bighorn Canyon and has been documented as nesting near Devil Canyon overlook and possibly in the Dry Head Canyon area. It forages in a variety of habitats in the area. Noise from PWC use may affect nesting individuals, though their placement in out-of-the way cliff areas precludes disturbance by onshore activities. In addition, PWC use would not occur on a regular basis in the canyon areas. Foraging activities of the falcons could potentially be affected by PWC noise, but any effects would be short-term. PWC use at Bighorn Lake may affect, but is not likely to adversely affect, peregrine falcons or their habitat.

Rocky Mountain bighorn sheep have been observed within the national recreation area along the Bad Pass Trail, in the Devil Canyon Overlook area, and in the Crooked Creek area. Known breeding and lambing areas for bighorn sheep are located within the steep canyon areas of the national recreation area where PWC use generally does not occur. Adverse impacts from PWC use are unlikely, as the population of sheep in the area is generally acclimated to human activity because of other visitor activities, such as boating, that occur within the recreation area. Any effects to the species would be short-term and would likely only result in temporary disturbance from PWC noise and activity to individuals that are foraging near the shoreline. PWC use at Bighorn Lake may affect, but is unlikely to adversely affect, Rocky Mountain bighorn sheep.

There are also three state species of concern listed in both Montana and Wyoming, which may occur within the national recreation area and are not protected under the *Endangered Species Act*, the Townsend's big-eared bat, the northern leopard frog, and the plains spadefoot toad. The Townsend's big-eared bat is not likely to occur in the analysis area, but is known to occur within old buildings within the national recreation area and could potentially occur in other portions of the national recreation area as well. PWC use would potentially affect, but would not likely adversely affect the Townsend's big-eared bat.

The northern leopard frog is common within the national recreation area. Potential habitat for the northern leopard frog found within the national recreation area is along springs, bogs, ponds and other areas of slow moving or shallow water. Suitable habitat is not likely to be found within areas frequented by PWC. In addition, the northern leopard frog is most active at night, when PWC are generally inactive. PWC use at Bighorn Lake may affect, but is not likely to adversely affect, the northern leopard frog or its associated habitat.

The plains spadefoot toad is common regionally, but classified as rare within the national recreation area. The preferred habitat for the plains spadefoot toad does not overlap with areas used by PWC. In addition, it is nocturnal, and spends most of its life underground, further reducing the likelihood that PWC use would adversely affect the plains spadefoot toad. Therefore, PWC use is not expected to adversely affect the plains spadefoot toad population within the national recreation area.

SPECIAL STATUS PLANTS

PWC provide access to the shoreline, and operators may disembark to explore shoreline areas. As a result, vegetation could be trampled by visitors.

There are no federally protected plant species that could potentially occur at Bighorn Lake. Of the other plant species of concern that are known to occur in the area, four species listed by Montana and Wyoming as special concern species are known to occur in the recreation area.

The persistent sepal yellowcress occurs in wetland areas associated with the floodplain south of the South Narrows of Bighorn Lake. This habitat is located in areas where PWC use is either non-existent or rare due to PWC use patterns and frequent low water levels. PWC use may affect, but is not likely to adversely affect the persistent sepal yellowcress.

The remaining sensitive plant species, including Hapeman's sullivantia, Lesica's bladderpod, and sweetwater milkvetch, are located on the plateau of the national recreation area, away from Bighorn Canyon and potential PWC user access and are not likely to be affected by PWC use (Morstad 2003).

Rabbit buckwheat is a species listed by the National Park Service as a rare plant. Rabbit buckwheat is not a shoreline species, and habitat for this species is not located adjacent or near Bighorn Lake. Therefore, PWC use is not expected to affect the rabbit buckwheat specimens within the national recreation area.

Cumulative Impacts. Cumulative impacts to the special status animal and plant species discussed above include impacts from visitor activities including non-PWC water-based or shoreline recreational activities such as boating, swimming, and fishing. In addition, visitors who focus more on upland activities such as picnicking, camping, hiking, and hunting also may cause disturbances to the above species. However, most visitor activities occur in or near already disturbed or developed sites such as boat ramps, marinas, and camp or picnic areas where wildlife habitat is generally lacking, thus adverse impacts to special status species are unlikely.

Lake operations and drought cycles could potentially affect special status species through lake level fluctuations and resulting disturbance and/or degradation of shoreline and aquatic habitat. It is possible that persistent sepal yellowcress would be affected by the seasonal drying of the floodplain adjacent to Bighorn Lake. However, the yellowcress has a tendency to colonize newly exposed mudflats and water fluctuation may encourage new populations that arise from existing seedbanks (Heidel and Fertig 2002). There are no other foreseeable planned actions within Bighorn Canyon that would cause impacts to the species.

Cumulative impacts from visitor activities, including PWC use, or lake level fluctuations within the recreation area may affect but are not likely to adversely affect federal or state listed species or other special status wildlife or plant species.

Conclusion. PWC use at Bighorn Canyon may affect, but is not likely to adversely affect, the following species with federal or state protection status: bald eagle, Rocky Mountain bighorn sheep, American

peregrine falcon, Townsend's big-eared bat, northern leopard frog, or persistent sepal yellowcress. There would be no effect to all other federal or state listed species, including mountain plover, plains spadefoot toad, Hapeman's sullivantia, Lesica's bladderpod, sweetwater milkvetch, or rabbit buckwheat. The identified special status species are either not permanent residents and not present during times of PWC use, are not usually accessible, are generally acclimated to human activity, or do not have preferred habitat in the areas used by PWC. Similarly, cumulative effects from all national recreation area visitor activities and lake level fluctuations may affect, but would not likely adversely affect, special status species, due to lack of species occurrences and access to their habitats.

Implementation of this alternative would not result in an impairment of threatened or endangered species.

Impacts of Alternative B — Reinstate PWC Use under a Special Regulation with Additional Management Prescriptions

Analysis. Under alternative B, PWC use would occur as under alternative A, with additional management prescriptions. Restrictions on PWC use would include a closure of the reservoir and shoreline south of the area known as the South Narrows. Buoys would be installed to delineate the boundary and PWC users would be required to stay north of this boundary. A user education program will also be implemented through vessel inspections, law enforcement contacts, and signing.

The closure of the southernmost portion of Bighorn Lake would eliminate noise and disturbance from the infrequent use that occurs in this area when water levels are sufficient for PWC use. Special status species that are known to occur in this area such as the bald eagle and persistent sepal yellowcress would benefit from the closure and no effect to these species would be expected from PWC under this alternative.

The establishment of a user education program would assist in lowering PWC accident frequency, as well as in increasing PWC user awareness of potential conflicts with wildlife. This would lead to a reduction in the potential for PWC-related effects to special status species relative to alternative A.

Cumulative Impacts. Under alternative B, cumulative impacts to special status species would be similar to alternative A and may affect, but would not likely adversely affect special status species or their habitat. Cumulative impacts would result from lake level fluctuations as well as visitor activities that are concentrated mostly in developed areas rather than in habitat for special status species.

Conclusion. Under alternative B, PWC use at Bighorn Lake may affect, but would not likely adversely affect, special status species including Rocky Mountain bighorn sheep, American peregrine falcon, Townsend's big-eared bat, or northern leopard frog. However, the potential for impacts to these species would be reduced relative to alternative A due to the decreased area of allowed PWC use and increased PWC user education efforts. Potential effects to the bald eagle and persistent sepal yellowcress would be eliminated by the closure of the area south of the South Narrows to PWC use and no effects from PWC would occur to these species under this alternative. There would be no PWC-caused effects to all other federal or state listed species including the mountain plover, plains spadefoot toad, Hapeman's sullivantia, Lesica's bladderpod, sweetwater milkvetch, or rabbit buckwheat as in alternative A. All impacts to special status species would be temporary and short term. Cumulative impacts may affect but would not be likely to adversely affect special status species and would result from lake level fluctuations as well as visitor activities that are concentrated mostly in developed areas rather than in habitat for special status species.

Implementation of this alternative would not result in an impairment of threatened or endangered species.

Impacts of the No-Action Alternative: Allow No PWC Use

Analysis. Under the no-action alternative, PWC use would not be reinstated in Bighorn Canyon. The elimination of PWC use would result in beneficial impacts to threatened or endangered and other special status species and their habitat due to the removal of PWC-related physical disturbance, noise, and emissions.

Cumulative Impacts. Contribution of PWC to overall cumulative impacts to federal or state listed animal and plant species would be eliminated. Because the numbers of PWC that would be eliminated are so few, cumulative impacts, including the activities of other visitors would be similar to those in alternatives A and B, and would continue to affect, but would not be likely to adversely affect, federal or state listed species. Cumulative adverse impacts from visitor activities would not be of sufficient duration or intensity to cause adverse impacts. Lake level fluctuations would also contribute to cumulative adverse impacts through potential short or long-term habitat disturbance.

Conclusion. PWC users would not be allowed to operate on Bighorn Lake, resulting in an elimination of PWC related effects to special status species and habitat relative to alternatives A and B. However, since PWC use at the recreation is minimal, cumulative effects from lake operations, non-PWC watercraft use, and other visitor activities would be similar and overall effects would remain the same as other alternatives. The no-action alternative may affect, but is unlikely to affect special status species in the national recreation area.

Implementation of this alternative would not result in an impairment of threatened or endangered species.

SHORELINES AND SENSITIVE SHORELINE VEGETATION

PWC are able to access areas that other types of watercraft may not, which may cause direct disturbance to vegetation. Indirect impact to shoreline vegetation may occur through trampling if operators disembark and engage in activities on shore. In addition, wakes created by personal watercraft may affect shorelines through erosion by wave action.

GUIDING REGULATIONS AND POLICIES

According to NPS management policy, natural shoreline processes such as erosion, deposition, overwash, inlet formation, and shoreline migration should continue without interference. Where the nature or rate of natural shoreline processes has been altered, the National Park Service is directed to identify alternatives for mitigating the effects of such activities or structures and for restoring natural conditions (NPS *Management Policies* [NPS 2000c] sec. 4.8.1.1). The National Park Service must also comply with the provisions of Executive Order 11990 (“Protection of Wetlands”), which requires federal agencies to avoid short- and long-term adverse impacts associated with the destruction or modification of wetlands whenever possible.

METHODOLOGY AND ASSUMPTIONS

Potential impacts to shoreline vegetation and to the shoreline itself (erosion that can affect shoreline communities) were evaluated based on the pattern of use of other watercraft on Bighorn Lake, the nature of the shoreline and vegetation present, and the professional judgment and observations of national

recreation area staff. To assess the magnitude of impacts from PWC use on shoreline vegetation, the following assumptions were made:

1. The majority of PWC users operate their craft in a lawful manner.

2. Approximately 5 PWC are on Bighorn Lake during a peak summer day for an average of 2 hours per day.

3. Generally, impacts are expected to be similar or slightly greater in 2012 relative to 2002 due to the slight increase in PWC use at Bighorn Lake of 1% per year. Approximately 6 PWC would be on the water in 2012 on a peak use day.

4. PWC users who disembark on the shore would travel no more than 100 feet inland and would follow existing trails.

IMPACT ANALYSIS AREA

The impact analysis area for the shoreline and sensitive shoreline vegetation assessment included the immediate water/land interface along the shoreline of Bighorn Lake where PWC use is allowed.

IMPACT TO SENSITIVE SHORELINE VEGETATION FROM PWC USE AND VISITOR TRAMPLING

Shoreline vegetation impacts were determined by examining the potential effects of PWC and visitor use on vegetation, according to type and sensitivity. The number of personal watercraft and visitors and their distribution was based on the analysis provided in the "PWC and Boating Use Trends" section. The following impact thresholds were established to describe the relative changes in shoreline vegetation under the various alternatives being considered:

Negligible: Impacts would have no measurable or perceptible changes in plant community size, integrity, or continuity.

Minor: Impacts would be measurable or perceptible but would be localized within a relatively small area. The overall viability of the plant community would not be affected and, if left alone, would recover.

Moderate: Impacts would cause a change in the plant community (e.g., abundance, distribution, quantity, or quality); however, the impact would remain localized.

Major: Impacts to the plant community would be substantial, highly noticeable, and permanent.

Impairment: PWC use would contribute substantially to the deterioration of the shoreline or shallow water environment to the extent that the park's shoreline or submerged vegetation would no longer function as a natural system. In addition, these adverse major impacts to national recreation area resources and values would:

- Contribute to deterioration of these resources to the extent that the park's purpose could not be fulfilled as established in its authorizing legislation;

- Affect resources key to the park's natural or cultural integrity or opportunities for enjoyment; or

- Affect the resource whose conservation is identified as a goal in the park's general management plan or other national recreation area planning documents.

Impacts of Alternative A — Reinstate PWC Use under a Special Regulation as Previously Managed

Analysis. PWC use could affect vegetation wherever use occurs near areas of substantial vegetation, or through PWC operators trampling plants on shore. Restrictions that were in place prior to the PWC closure as described in the "Alternatives" chapter would be applicable. Due to low water and air temperatures throughout the majority of the year, primary PWC use occurs from June through September. PWC use levels are low relative to other recreation area activities, with approximately 5 PWC users on a peak use summer day in 2002, as noted in the "Methodology and Assumptions" section. PWC would be allowed to launch from sites located at Ok-A-Beh and Horseshoe Bend marinas and Barry's Landing. Ok-A-Beh Marina is the primary area of PWC use in the recreation area. Depending on water levels, use may also occur at Horseshoe Bend and Barry's Landing.

PWC use does not generally occur within the canyon areas due to lack of landing areas and rough waters. Accessible shoreline areas along Bighorn Lake for PWC users and other visitors are limited due to steep canyon walls and fluctuations in water levels associated with reservoir operations and drought cycles. Shoreline access is primarily limited to developed launch sites and campgrounds.

Due to water level fluctuations from lake operations, as well as the steep-walled canyon that constitutes a majority of the lake, substantial areas of shoreline vegetation are lacking at Bighorn Canyon. In a normal year, the shoreline is under water from mid-July to mid-September, and when exposed it consists mainly of gravel. In most areas of the lake, the closest vegetation is generally 20–50 feet above the water on canyon ledges.

Sensitive riparian and/or wetland vegetation is not found on the shoreline of Bighorn Canyon, with the exception of the area in the Yellowtail Wildlife Habitat area located south of the South Narrows. PWC use occurs in this area only infrequently as most use is concentrated around boat launches and other facility areas, and because water levels are often too low for watercraft use due to lake operations or drought cycles. Foot access into areas from PWC operators would also be limited due to the difficulty of water access. Therefore, adverse impacts to shorelines and shoreline vegetation from PWC use would be negligible and short-term.

Cumulative Impacts. Non-PWC watercraft makes up almost 96% of all boating use at Bighorn Canyon. In some locations, visitors may access shoreline areas and trails by these other vessels or by automobile. Due to the lack of sensitive shoreline vegetation in areas of major visitor use, adverse impacts from visitor access would be negligible to minor.

Shoreline erosion is primarily caused by lake operations and drought, which could potentially cause minor to moderate adverse impacts to sensitive vegetation in areas through lake level fluctuations.

Conclusion. PWC use would result in negligible short-term adverse effects on shoreline vegetation due to low PWC use and the lack of shoreline vegetation due to the canyon environment present throughout the majority of the national recreation area. According to visitor use patterns, sensitive wetland and riparian communities are located in areas not often utilized by PWC due to accessibility issues related to water level cycles. Cumulative adverse impacts from other watercraft and visitor activities would be negligible

to minor and short-term. Lake level fluctuations from drought or lake operations would potentially have minor to moderate adverse impacts to sensitive vegetation in the Yellowtail Wildlife Habitat area.

Implementation of this alternative would not result in an impairment of shoreline vegetation.

Impacts of Alternative B — Reinstate PWC Use under a Special Regulation with Additional Management Prescriptions

Analysis. Under alternative B, PWC use would occur as under alternative A, with additional management prescriptions. Restrictions on PWC use would include a closure of the reservoir and shoreline south of the area known as the South Narrows. Buoys would be installed to delineate the boundary and PWC users would be required to stay north of this boundary. A user education program will also be implemented through vessel inspections, law enforcement contacts, and signing.

The closure of the area south of the South Narrows would have potential benefits to the wetland and riparian communities during times when water levels are sufficient for PWC access. In addition, the user education program would increase the awareness of visitors to the importance of these vegetation communities. Impacts from PWC use to shorelines and sensitive shoreline vegetation would remain negligible, adverse, and short-term.

Cumulative Impacts. Cumulative adverse impacts related to other watercraft and visitor activities would be the same as described for alternative A and would be negligible to minor. Impacts from water level fluctuations to shorelines and shoreline vegetation would continue to be minor to moderate.

Conclusion. Reduced PWC access would eliminate adverse impacts in the southernmost portion of the national recreation area during times when there are sufficient water levels to provide access by PWC, resulting in beneficial impacts to sensitive shoreline vegetation. Cumulative adverse impacts from PWC and other watercraft use and visitor activities would remain negligible to minor, while impacts from lake level fluctuations would remain minor to moderate.

Implementation of this alternative would not result in an impairment of shoreline vegetation.

Impacts of the No-Action Alternative: Allow No PWC Use

Analysis. PWC use on Bighorn Lake would not be reinstated under the no-action alternative. There would be beneficial impacts to sensitive shoreline vegetation from eliminated PWC access and no direct potential for physical disturbance from PWC operation.

Cumulative Impacts. Cumulative impacts would be similar to those described for alternative A, except that PWC contribution to these impacts would be eliminated. Use of other watercraft and visitor activities would continue to be a source of negligible to minor adverse impacts on sensitive shoreline vegetation. Physical processes such as lake level fluctuations would cause minor to moderate adverse impacts on sensitive shoreline vegetation.

Conclusion. PWC would not be allowed to operate on Bighorn Lake, resulting in beneficial impacts to shoreline vegetation. Cumulative impacts from other watercraft activity and visitor activities would continue, and would be negligible to minor. Lake fluctuations due to lake operations or drought would have minor to moderate adverse impacts on sensitive shoreline vegetation. PWC contribution to these impacts would be eliminated.

Implementation of this alternative would not result in an impairment of shoreline vegetation.

VISITOR USE AND EXPERIENCE

GUIDING REGULATIONS AND POLICIES

NPS *Management Policies 2001* state that the enjoyment of park resources and values by the people of the United States is part of the fundamental purpose of all parks and that the National Park Service is committed to providing appropriate, high-quality opportunities for visitors to enjoy the parks. Because many forms of recreation can take place outside a national park setting, the National Park Service will therefore seek to:

- provide opportunities for forms of enjoyment that are uniquely suited and appropriate to the superlative natural and cultural resources found in a particular unit
- defer to local, state, and other federal agencies; private industry; and non-governmental organizations to meet the broader spectrum of recreational needs and demands that are not dependent on a national park setting

Unless mandated by statute, the National Park Service will not allow visitors to conduct activities that:

- would impair park resources or values
- would create an unsafe or unhealthful environment for other visitors or employees
- are contrary to the purposes for which the park was established
- would unreasonably interfere with the atmosphere of peace and tranquility, or the natural soundscape maintained in wilderness and natural, historic, or commemorative locations within the park; NPS interpretive, visitor service, administrative, or other activities; NPS concessioner or contractor operations or services; or other existing, appropriate park uses.

Part of the purpose of Bighorn Canyon National Recreation Area is to offer opportunities for recreation, education, inspiration, and enjoyment. The national recreation area is substantial for the outstanding scenic and recreational values of Bighorn Lake; the history of over 10,000 years of continuous human habitation; and the Pryor Mountain Wild Horse Range and Yellowtail Wildlife Habitat area. One of the national recreation area's purposes is to "provide for public outdoor recreation use and enjoyment of Yellowtail Reservoir and lands adjacent thereto…and for the preservation of the scenic, scientific and historic features contributing to public enjoyment of such lands and waters…" To achieve Bighorn Canyon's goals, two long-term (five-year) visitor goals were identified in the *Strategic Plan:*

- *Visitor Satisfaction* — By September 30, 2005, 89% of visitors to Bighorn Canyon National Recreation Area are satisfied with appropriate facilities, services, and recreational opportunities.
- *Visitor Safety* — By September 30, 2005, the number of Bighorn Canyon National Recreation Area visitor accidents/incidents is reduced from the FY 1992 – FY 1996 annual average of 4.8 to 3 (a 62% reduction).

Both goals focus on maintaining high visitor satisfaction by means of appropriate and safe recreational opportunities and experiences.

The national recreation area's mission directs the park to provide "…the necessary recreational opportunities and facilities to allow for public use and enjoyment of Yellowtail Reservoir and adjacent lands managed by the National Park Service"(*Strategic Plan* [NPS 2001c]).

METHODOLOGIES AND ASSUMPTIONS

The purpose of this impact analysis was to determine if PWC use at Bighorn Canyon National Recreation Area is compatible or in conflict with the purpose of the park, its visitor experience goals, and the direction provided by NPS *Management Policies* (NPS 2000c). Thus, these policies and goals were integrated into the impact thresholds.

To determine impacts, the current level of PWC use (prior to the November 7, 2002 PWC closure) was calculated for the recreation area (see the "PWC and Boating User Trends" section). Staff observations were evaluated to determine visitor attitudes and satisfaction in areas where personal watercraft were used.

The potential for change in visitor experience was evaluated by identifying projected increases or decreases in both personal watercraft and other visitor uses, and determining whether these projected changes would affect the desired visitor experience and result in greater safety concerns or additional user conflicts.

Bighorn Canyon is the primary destination for PWC use in the area, although there are several locations within 200 miles that permit PWC use. In Wyoming, these include: Buffalo Bill Reservoir (52 miles); Boysen Reservoir (123 miles); Ocean Lake (180 miles); and Pilot Butte Dam (183 miles). Alternate locations for PWC use in Montana include: the Tongue River Reservoir (90 miles) and Cooney Reservoir (150 miles).

IMPACT ANALYSIS AREA

In terms of PWC use, the impact analysis area is defined as all areas of Bighorn Canyon National Recreation Area that are open to PWC. This includes the entire body of Bighorn Lake. The impact analysis area does not include waters downstream (to the north) of the Yellowtail Dam which are closed to motorized vessel use. In addition, PWC use may affect visitors at beaches, trails, and campgrounds near the shoreline, such that visitors within 200 feet of the shore of Bighorn Lake are considered to be within the affected area.

IMPACT OF PERSONAL WATERCRAFT ON VISITOR EXPERIENCE GOALS

The following thresholds were defined:

Negligible: Visitors would not likely be aware of the effects associated with changes proposed for visitor use and enjoyment of park resources.

Minor: Visitors would likely be aware of the effects associated with changes proposed for visitor use and enjoyment of park resources; however the changes in visitor use and experience would be slight and likely short term. Other areas in the park would remain available for similar visitor experience and use without derogation of park resources and values.

Moderate: Visitors would be aware of the effects associated with changes proposed for visitor use and enjoyment of park resources. Changes in visitor use and experience would be readily apparent and likely long term. Other areas in the park would remain available for similar visitor experience and use without derogation of park resources and values, but visitor satisfaction might be measurably affected (visitors could be either satisfied or dissatisfied). Some visitors who desire to continue their use and enjoyment of the activity/visitor experience would be required to pursue their choice in other available local or regional areas.

Major: Visitors would be highly aware of the effects associated with changes proposed for visitor use and enjoyment of park resources. Changes in visitor use and experience would be readily apparent and long term. The change in visitor use and experience proposed in the alternative would preclude future generations of some visitors from enjoying park resources and values. Some visitors who desire to continue their use and enjoyment of the activity / visitor experience would be required to pursue their choice in other available local or regional areas.

Impacts of Alternative A — Reinstate PWC Use under a Special Regulation as Previously Managed

Analysis. PWC operators under alternative A would be allowed on Bighorn Lake, with limitations only in areas previously managed with use restrictions as described in the "Alternatives" chapter. Based on an expected increase of 1% per year, PWC use is expected to increase from 5 personal watercraft on a peak-use summer season day to 6 PWC per day by 2012.

Impact on PWC Users — There would be no change to PWC use or activity as compared to conditions prior to the November 7, 2002 PWC closure. Alternative A would have negligible impact on the visitor experience goals of PWC users.

Impact on Other Boaters — Other boaters would interact with PWC operators on an increasing basis as overall boating numbers increase over the next 10 years. PWC use is expected to increase at the same rate as other boat use; however, PWC would comprise approximately 4% of total boats on Bighorn Lake in 2012. Higher-use areas for PWC and boaters include Horseshoe Bend and the Ok-A-Beh areas.

Generally, few non-motorized craft (sea kayaks, canoes, and windsurfers) use Bighorn Lake, so interactions with these user groups would be infrequent. Under alternative A, short- and long-term impacts on non-motorized boaters would be negligible adverse.

Motorized boats are more likely to interact with personal watercraft. The most common area for personal watercraft / boater interaction is near the boat launches, as the majority of motorized boats enter the water at the marinas and then motor into the main body of the lake. With increasing boat and PWC numbers although minimal over the next 10 years, the potential for interactions between the user groups would also increase. Based on this analysis, alternative A would have short- and long-term negligible adverse impacts on the visitor experience goals of boaters using non-motorized and other motorized vessels.

Impact on Other Visitors — Campers**,** swimmers, anglers, hikers, and other shoreline visitors would have contact with PWC users. Shoreline areas that are popular with both PWC and other shoreline users include Horseshoe Bend and the Ok-A-Beh area. The Wyoming state boating regulations require a 100-foot no-wake speed zone around any persons in the water, and Montana state regulations require a 200-foot no-wake speed from persons in the water and 75 feet from person on the shore engaged in fishing.

Swimming is permitted in Bighorn Lake, and designated swim beaches and boat launch areas occur at Horseshoe Bend and Ok-A-Beh. Swimming and PWC use could occur together at these locations and could result in conflict. Due to the projected increase in PWC numbers and continued violations of flat-wake speeds, PWC use under alternative A would result in short- and long-term negligible adverse impact on the experience of swimmers.

There are three campgrounds that have boat launch facilities, and thus could have PWC use in the direct vicinity of the campground: Horseshoe Bend, Barry's Landing, and Ok-A-Beh. Medicine Creek camp area is the only established back county campsite easily accessible to backpackers, and this site also has boat-in access. Black Canyon campground has boat-in access only. There is potential for disturbance to campers by PWC at all shoreline campsites, especially related to sound issues in the canyon sites. (See full description of these impacts in the "Soundscapes" section.) Under alternative A, PWC use would have short- and long-term negligible to minor adverse impacts on the experience of visitors to park campgrounds.

The entire shoreline is open to hiking, but the only designated shoreline trails occur at Barry's Landing, into Medicine Creek, and along Layout Creek. PWC use in areas that are popular with both personal watercraft and other shoreline visitors (hikers, anglers) could affect visitors seeking natural quiet in the canyon areas of the national recreation area; however, most of the shoreline of Bighorn Lake is difficult to access due to the steep topography, and shoreline use is not high outside of the developed areas. PWC use under alternative A would not result in a noticeable change in the experience of shoreline visitors; although, the expected increase in PWC use at congested shoreline areas of Bighorn Lake would result in long-term negligible to minor adverse impacts on the experiences of these shoreline visitors. Visitors seeking natural quiet would experience a minor to moderate adverse impact due to PWC use.

Cumulative Impacts. Activities that could affect visitor experiences include the number and activities of other visitors and noise from motorboats. The Bureau of Reclamation regulates the lake level; however, it is impossible to predict the effects of drought conditions and downstream water needs on future lake levels and the impacts related to lake level fluctuations. Predictable cumulative impacts related to the use of personal watercraft, motorized boats, other visitor activities, and lake fluctuations would be negligible adverse over the short and long term.

Conclusion. Under this alternative a negligible to minor adverse impacts on experiences for most visitors in the short and long term would occur. Swimmers and other visitors seeking natural quiet would be most affected by PWC use, especially at the designated swim beaches and within the canyon section of the national recreation area. PWC use would have long-term, minor to moderate adverse impacts on those visitors desiring natural quiet. PWC use would have negligible adverse impacts on other boaters due to increased congestion at popular boat launches. Most visitors would experience negligible to minor adverse effects under this alternative and would be satisfied with their experiences.

Cumulative effects of PWC use, other watercraft, and other visitors would result in short- and long-term, negligible adverse impacts.

Impacts of Alternative B — Reinstate PWC Use under a Special Regulation with Additional Management Prescriptions

Analysis. PWC use would be reinstated as under alternative A, with additional management prescriptions including a closure of the reservoir and shoreline south of the area known as the South Narrows. Buoys would be installed to delineate the boundary, and PWC would be required to stay north of this boundary.

Impact on PWC Users — The use restriction south of the South Narrows would have a negligible adverse impact on the experience of PWC users. This area is not popular with PWC users and the rest of the lake would still be open to PWC use; however, the restriction does eliminate the possibility of PWC use in this area. Overall, alternative B would have a long-term negligible adverse impact on PWC users at Bighorn Canyon.

Impact on Other Boaters — As under alternative A, other boaters (motorized and non-motorized) would interact with PWC operators and experience impacts similar to alternative A. The PWC use restriction south of the South Narrows would benefit other boaters using this area, as there would be no potential for PWC to adversely impact their experience. Further, since this part of Bighorn Canyon has not historically had high PWC use, closure south of the South Narrows would not force a large number of PWC to other parts of the lake and shoreline, impacting other boaters. Therefore, impacts on all boaters south of the South Narrows will be beneficial, and north of the South Narrows will be negligible adverse.

Impact on Other Visitors — As under alternative A, campers**,** swimmers, water skiers, anglers, hikers, and other shoreline visitors to the lake would interact with PWC users and experience impacts similar to alternative A. Closure of the lake south of the South Narrows would not result in PWC users relocating to other parts of the lake since this is not a high PWC use area. Thus, impacts would be the similar to alternative A north of the South Narrows – negligible to minor adverse impacts to shoreline visitors and minor to moderate adverse to those seeking natural quiet. South of the South Narrows impacts would be beneficial to all visitors.

Cumulative Impacts. Cumulative impacts would be the same as alternative A. Predictable cumulative impacts related to the use of personal watercraft, motorized boats, and other visitor activities would be negligible adverse over the short and long term.

Conclusion. Designation of the closed area south of the South Narrows would have a negligible adverse impact on most PWC users since this area has not had high PWC use, and most of the reservoir would still be open for use. Other boaters and all shoreline users would experience negligible adverse impacts north of the South Narrows and beneficial impacts south of the South Narrows.

Cumulative effects of PWC use, other watercraft, and other visitors would result in long-term, negligible adverse impacts.

Impacts of the No-Action Alternative: Allow No PWC Use

Analysis. Personal watercraft use would not be reinstated and visitors would no longer be allowed to participate in this form of recreation in the national recreation area. PWC are estimated to comprise 4% of all vessels on the reservoir, which represents a small percentage of overall visitors. Based on current use projections and an average 1.5 users per PWC, in 2012 approximately 9 PWC riders would not be able to enjoy this experience at Bighorn Canyon on a typical summer season day. This number constitutes a very small percentage of the daily visitation, and would not preclude the national recreation area from its goal of offering a wide range of recreational activities because of the other water-based recreation activities available, such as motorized boating.

Impact on PWC Users — Continuing the ban of PWC use would have a minor adverse impact on PWC users who are accustomed to recreating on Bighorn Lake (see "PWC and Boating Use Trends" section for detailed assumptions of future use). Discontinuing PWC use would not necessarily preclude a visit to the recreation area by PWC owners. Nationally, approximately 68% of PWC owners previously owned powerboats (NTSB 1998). Current PWC users could still use a motorboat or other watercraft on all of the

lake and could continue to experience activities such as hiking, sightseeing, and camping. The level of impact to all PWC users is expected to be minor adverse in the short term and long term.

Impact on Other Boaters — Banning PWC use from Bighorn Lake would eliminate interactions between other boaters and PWC operators on these waters, and these other boaters would experience a beneficial impact.

Impact on Other Visitors — Banning PWC use would have a beneficial impact on other shoreline users, especially swimmers and anglers. Campers, shoreline hikers, and anglers would experience more natural quiet in the traditional high PWC use areas, but would still be exposed to sounds from other watercraft.

Cumulative Impacts. Cumulative impacts overall would be similar to alternatives A and B. On a regional basis the no-action alternative would likely result in a negligible adverse effect to PWC activities on other water bodies in the region as a result of PWC users going to other locations to enjoy this activity. The impact would be negligible because of the small number of personal watercraft that would be displaced from Bighorn Lake to other locations.

Conclusion. The no-action alternative would have a beneficial impact on the experiences of most non-PWC using visitors to the recreation area. Impacts on PWC users would be long term, minor, and adverse.

Cumulative effects of PWC use, other watercraft, and other visitors would result in short- and long-term negligible impacts.

VISITOR CONFLICTS AND SAFETY

GUIDING REGULATIONS AND POLICIES

In addition to the guiding regulations and policies discussed in the "Visitor Use and Experience" section, the NPS *Management Policies 2001* state that the agency is committed to providing appropriate, high-quality opportunities for visitors to enjoy the parks. The policies also state, "While recognizing that there are limitations on its capacity to totally eliminate all hazards, the National Park Service and its concessioners, contractors and cooperators will seek to provide a safe and healthful environment for visitors and employees" (Section 8.2.5.1) Further, the National Park Service will strive to protect human life and provide for injury-free visits (Section 8.2.5).

Director's Order #9: Law Enforcement Program (NPS 2000a), in conjunction with *Reference Manual 9: Law Enforcement,* establishes and defines standards and procedures for NPS law enforcement. Along with education and resource management, law enforcement is an important tool in achieving this mission. Commissioned rangers perform resource stewardship, education, and visitor use management activities, including law enforcement. They provide for tranquil, sustainable use and enjoyment of park resources while simultaneously protecting these resources from all forms of degradation. The objectives of the law enforcement program are to (1) prevent criminal activities through resource education, public safety efforts, and deterrence, (2) detect and investigate criminal activity, and (3) apprehend and successfully prosecute criminal violators.

PWC users would continue to abide by Wyoming and Montana state watercraft laws and regulations. Current Wyoming and Montana state boating laws applicable to PWC use that have been incorporated into all action alternatives and are listed in the "Affected Environment" chapter.

Water patrols and enforcement, in conjunction with cooperating agencies, would continue on an irregular basis during the primary PWC-use season (mid-June to Labor Day).

METHODOLOGY AND ASSUMPTIONS

The methodology for visitor conflicts and safety is similar to that used for visitor experience. The potential visitor-related impacts attributable to personal watercraft — a higher rate of accidents than for other watercraft, conflicts with other park users, negative effects on some types of visitor experiences — could potentially affect the mandate to provide for injury-free visits. Potential impacts were identified based on the number and activities of personal watercraft operating within the area, the number and activities of other visitors in an area, and the proximity of these user groups.

It is assumed that Wyoming and Montana state PWC regulations are enforced within the national recreation area. These regulations govern PWC activities near the shore, the timing of use, and the age and educational requirements of operators.

IMPACT ANALYSIS AREA

In terms of PWC use, the impact analysis area is defined as all areas of Bighorn Canyon National Recreation Area that are open to PWC use as described in the *Superintendent's Compendium* (NPS n.d.). This includes the entire body of Bighorn Lake. The impact analysis area does not include waters downstream or north of the Yellowtail Dam which are closed to motorized vessel use. In addition, PWC use may affect visitors at beaches, trails, and campgrounds near the shoreline, such that visitors within 200 feet of the shore of Bighorn Lake are considered to be within the affected area.

IMPACT OF PWC USE AND CONFLICTING USES ON VISITOR SAFETY

The impact intensities for both visitor conflicts and safety follow. Where impacts to visitor experience or visitor safety become moderate or minor, it is assumed that current visitor satisfaction and safety levels would begin to decline and the park would not be achieving some of its long-term visitor goals.

Negligible: The impact to visitor safety would not be measurable or perceptible.

Minor: The impact would be measurable or perceptible, and it would be limited to a relatively small number of visitors at localized areas. Impacts to visitor safety could be realized through a minor increase or decrease in the potential for visitor conflicts in current accident areas.

Moderate: The impact to visitor safety would be sufficient to cause a permanent change in accident rates at existing low accident locations or to create the potential for additional visitor conflicts in areas that currently do not exhibit noticeable visitor conflict trends.

Major: The impact to visitor safety would be substantial either through the elimination of potential hazards or the creation of new areas with a high potential for serious accidents or hazards.

Impacts of Alternative A — Reinstate PWC Use under a Special Regulation as Previously Managed

Analysis. PWC operation under alternative A would be allowed on national recreation area waters, with limitations only in areas previously managed with use restrictions as described in the "Alternatives" chapter. Based on an increase of 1% per year PWC use is expected to increase from 5 personal watercraft on a peak-use summer season day to 5.5 PWC per day by 2012.

Personal Watercraft /Swimmer Conflicts — The greatest potential for conflict between PWC and swimmers is at the swim beaches at Horseshoe Bend and Ok-A-Beh. When PWC operators fall or are thrown from their PWC, the machine can continue running, and documented cases describe unmanned PWC harming swimmers in Michigan and Florida (NTSB 1998). State boating regulations that require flat-wake speed zone around any swimming area or person on the shore engaged in fishing would be enforced. An estimated 5.5 PWC would be operated on the lake during peak use days in 2012, and would likely concentrate near popular launch/swim areas and may violate the flat-wake speed rule to beach, pick up passengers, or change operators. No PWC related accidents have occurred involving a swimmer. Due to the concentration of visitors that use these areas, impacts regarding swimmer safety at these locations are anticipated to be negligible to minor adverse.

The remaining park locations would experience little or no conflict between PWC users and swimmers, because there are few swimmers in other areas of the national recreation area that are frequented by PWC. Thus, conflicts in these segments would constitute negligible adverse impacts on visitor safety.

Personal Watercraft / Other Boat Conflicts — PWC represent an estimated 4% of all vessels at Bighorn Lake. Potential for incidents or accidents at congested boat ramps exists but the impact of PWC use on safety would be considered negligible to minor. PWC may come into conflict with non-motorized boats in the flat-wake speed areas, where PWC have violated the flat-wake speed rules. Impacts to other boaters would be negligible to minor adverse.

Overall, PWC use would have negligible to minor adverse impacts on other boat users at Bighorn Canyon National Recreation Area and would be concentrated primarily at the boat launches.

Personal Watercraft / Other Visitors Conflicts — Bighorn Lake and its shoreline are used by a variety of visitors, including, campers**,** anglers, and hikers; however, due to the steep topography of the shoreline, most activity is concentrated near developed areas. Shoreline areas that are popular with both PWC and other shoreline users include Horseshoe Bend and Ok-A-Beh. Since lakewide PWC use is expected to increase by less than one PWC per peak-use day by 2012, conflicts and safety issues between PWC users and other visitors would be expected to increase minimally. Under this alternative, PWC use impacts on the safety of non-boating visitors would likely be negligible adverse.

There are five campgrounds at Bighorn Canyon that have boat launch facilities or boat access, and thus could have PWC use and potential conflicts or safety issues in the direct vicinity of the campground: Horseshoe Bend, Barry's Landing, Ok-A-Beh, Medicine Creek and Black Canyon. Horseshoe Bend and Ok-A-Beh have the most potential for conflicts, as they receive more visitation than the others. Under alternative A, PWC use would have negligible adverse impacts on the safety of visitors to park campgrounds.

Cumulative Impacts. The primary activities at Bighorn Canyon National Recreation Area that could affect visitor experiences include the number and activities of other visitors and noise from motorboats. The Bureau of Reclamation regulates the lake level; however, it is impossible to predict the effects of drought conditions and downstream water needs on future lake levels and the impacts related to lake level

fluctuations. Predictable cumulative impacts related to the use of personal watercraft, motorized boats, and other visitor activities would be negligible adverse over the short and long term.

Conclusion. Reinstated PWC use would have negligible to minor adverse impacts over the short and long term related to visitor conflicts and safety issues. Conflicts would mostly occur at high use areas such as Horseshoe Bend and Ok-A-Beh between personal watercraft and other watercraft. Conflicts at other locations would remain negligible because use is lower and conflicts would be less likely to occur.

Cumulative impacts related to visitor conflicts and safety would be negligible adverse for all user groups in the short and long term.

Overall, most visitors would experience negligible to minor adverse effects under this alternative and would be satisfied with their experiences.

Impacts of Alternative B — Reinstate PWC Use under a Special Regulation with Additional Management Prescriptions

Analysis. PWC use would be reinstated as under alternative A, with additional management prescriptions including a closure of the reservoir and shoreline south of the area known as the South Narrows. Buoys would be installed to delineate this boundary, with PWC required to stay north of this boundary.

Personal Watercraft /Swimmer Conflicts – The greatest potential for conflict between PWC and swimmers is at the designated swim beaches at Horseshoe Bend and Ok-A-Beh. The area south of the South Narrows is not a high swim-use area, thus impacts on swimmers related to visitor safety and conflicts would be negligible adverse.

Personal Watercraft/Other Boat Conflicts — Impacts on other boaters would be similar to alternative A north of the South Narrows, and would be negligible to minor adverse. South of the South Narrows, impacts on other boaters would be beneficial, due to lack of PWC presence.

Personal Watercraft/Other Visitors Conflicts — Bighorn Lake and its shoreline are used by a variety of visitors, including, campers**,** anglers, and hikers; however, due to the steep topography of the shoreline, most activity is concentrated near developed areas. Shoreline areas that are popular with both PWC and other shoreline users include Horseshoe Bend and Ok-A-Beh. Since lakewide PWC use is expected to increase by one PWC per high-use day by 2012, conflicts and safety issues between PWC users and other visitors would be expected to increase minimally north of the South Narrows, and would be negligible adverse. South of the South Narrows, impacts on safety and conflict issues related to all other visitors would be beneficial.

Cumulative Impacts. Cumulative impacts would be similar to alternative A. Predictable cumulative impacts related to the use of personal watercraft, motorized boats, and other visitor activities would be negligible adverse over the short and long term.

Conclusion. Reinstated PWC use with the management prescriptions of alternative B would have beneficial impacts on visitor conflict and safety goals south of the South Narrows. North of the South Narrows impacts on visitor conflict and safety goals would be negligible adverse.

Cumulative impacts related to visitor conflicts and safety would be negligible to minor adverse for all user groups in the short and long term, particularly near the high use areas.

Impacts of the No-Action Alternative: Allow No PWC Use

Analysis. Personal watercraft use would continue to be prohibited and visitors would not be allowed to participate in this form of recreation in the national recreation area. PWC are estimated to comprise 4% of all vessels at Bighorn Canyon, which represents a small percentage of overall visitors. Based on current use projections and an average 1.5 users per PWC, in 2012 approximately 9 PWC riders would not be able to enjoy this experience at Bighorn Canyon on a typical summer season day. This number constitutes a very small percentage of the daily visitation, and would not preclude Bighorn Canyon from its goal of offering a wide range of recreational activities.

Personal Watercraft /Swimmer Conflicts — Continuing to prohibit PWC use would have a beneficial impact on the visitor conflict and safety goals of swimmers.

Personal Watercraft/Other Boat Conflicts — The continued ban of PWC use would have a beneficial impact on the visitor conflict and safety goals of other boaters.

Personal Watercraft/Other Visitors Conflicts — Continuing the ban of PWC use would have a beneficial impact on the visitor conflict and safety goals of other visitors.

Cumulative Impacts. Cumulative impacts would be similar to alternatives A and B. Predictable cumulative impacts related to the use of other watercraft and other visitor activities would be negligible adverse over the short and long term. On a regional basis the no-action alternative would likely result in a negligible adverse effect to PWC activities on other water bodies in the region as a result of PWC users going to other locations to enjoy this activity.

Conclusion. Continuing to ban PWC use would have a beneficial impact on the visitor conflict and safety goals of swimmers, other boaters, and all other visitors. Cumulative impacts related to visitor conflicts and safety would be negligible adverse for all user groups in the short and long term.

CULTURAL RESOURCES

GUIDING REGULATIONS AND POLICIES

The National Park Service's primary interest in these places stems from its responsibilities under the following legislation:

The NPS Organic Act — Responsibility to conserve the natural and historic objects within parks unimpaired for the enjoyment of future generations

National Historic Preservation Act — Responsibility to preserve, conserve, and encourage the continuation of the diverse traditional prehistoric, historic, ethnic, and folk cultural traditions that underlie and are a living expression of our American heritage

American Indian Religious Freedom Act — Responsibility to protect and preserve for American Indians access to sites, use and possession of sacred objects, and the freedom to worship through ceremonials and traditional rites

Archeological Resources Protection Act — Responsibility to secure, for the present and future benefit of the American people, the protection of archeological resources and sites that are on public lands

Executive Order 13007 — Responsibility to (1) accommodate access to and ceremonial use of Indian sacred sites by Indian religious practitioners, and (2) avoid adversely affecting the physical integrity of such sacred sites

Antiquities Act of 1906 (Public Law. 59-209) — The *Antiquities Act* authorized the president to establish historic landmarks and structures as monuments owned or controlled by the United States government. It also instituted a fine for unauthorized collection of artifacts

In accordance the *Management Policies 2001*, the National Park Service must be respectful of these ethnographic resources, and carefully consider the effects that NPS actions may have on them (*Management Policies* [NPS 2000c] sec. 5.3.5.3).

METHODOLOGY AND ASSUMPTIONS

In this environmental assessment impacts to cultural resources (archeological resources, historic structures, the cultural landscape, and ethnographic resources are described in terms of type, context, duration, and intensity, which is consistent with the CEQ regulations. These impact analyses are intended, however, to comply with the requirements of both the *National Environmental Policy Act* and Section 106 of the *National Historic Preservation Act* (NHPA). In accordance with the Advisory Council on Historic Preservation's regulations implementing Section 106 (36 CFR 800, "Protection of Historic Properties"), impacts to cultural resources were identified and evaluated by (1) determining the area of potential effects; (2) identifying cultural resources present in the area of potential effects that were either listed on or eligible to be listed on the National Register of Historic Places; (3) applying the criteria of adverse effect to affected cultural resources either listed in or eligible to be listed on the national register; and (4) considering ways to avoid, minimize, or mitigate adverse effects.

Under the advisory council's regulations a determination of either *adverse effect* or *no adverse effect* must also be made for affected, national register eligible cultural resources. An *adverse effect* occurs whenever an impact alters, directly or indirectly, any characteristic of a cultural resource that qualify it for inclusion on the national register (e.g., diminishing the integrity of the resource's location, design, setting, materials, workmanship, feeling, or association). Adverse effects also include reasonably foreseeable effects caused by the preferred alternative that would occur later in time, be farther removed in distance or be cumulative (36 CFR 800.5, "Assessment of Adverse Effects"). A determination of *no adverse effect* means there is an effect, but the effect would not diminish in any way the characteristics of the cultural resource that qualify it for inclusion on the national register.

CEQ regulations and DO #12 (NPS 2001a) also call for a discussion of the appropriateness of mitigation, as well as an analysis of how effective the mitigation would be in reducing the intensity of a potential impact (e.g., reducing the intensity of an impact from major to moderate or minor). Any resultant reduction in intensity of impact due to mitigation, however, is an estimate of the effectiveness of mitigation only under the *National Environmental Policy Act*. It does not suggest that the level of effect as defined by Section 106 is similarly reduced. Although adverse effects under Section 106 may be mitigated, the effect remains adverse.

A Section 106 summary is included at the end of the analysis section and is intended to meet the requirements of the *National Historic Preservation Act*. It also is intended to provide an assessment of the effect of the undertaking (implementation of the alternative) on cultural resources, based on criteria found in the advisory council's regulations.

IMPACT ANALYSIS AREA

The impact analysis area for cultural resources is Bighorn Lake and the surrounding shoreline area, extending inland to approximately 200 feet. This 200-foot inland segment is assumed to provide a more encompassing range of assessment, based on the distance of PWC operation from the shoreline and the likely distance PWC users would travel inland.

IMPACTS ON ARCHEOLOGICAL SITES AND SUBMERGED RESOURCES

Certain important research questions about human history can only be answered by the actual physical material of cultural resources. Archeological resources have the potential to answer, in whole or in part, such research questions. An archeological site(s) can be eligible to be listed on the National Register of Historic Places if the site(s) has yielded, or may be likely to yield, information important in prehistory or history. An archeological site(s) can be nominated to the national register in one of three historic contexts or levels of significance: local, state, or national (see National Register Bulletin #15, *How to Apply the National Register Criteria for Evaluation*). For purposes of analyzing impacts to archeological resources, thresholds of change for the intensity of an impact are based upon the potential of the site(s) to yield information important in prehistory or history, as well as the probable historic context of the affected site(s):

Negligible: The impact is at the lowest level of detection or barely measurable, with no perceptible consequences, either adverse or beneficial, to archeological resources. For purposes of Section 106, the determination of effect would be *no adverse effect*.

Minor: Adverse Impact — The impact would affect an archeological site with the potential to yield information important in prehistory or history. The historic context of the affected site(s) would be local. For purposes of Section 106, the determination of effect would be *adverse effect*.

Beneficial impact — A site would be preserved in its natural state. For purposes of Section 106, the determination of effect would be *no adverse effect*.

Moderate: Adverse Impact — The impact would affect an archeological site with the potential to yield information important in prehistory or history. The historic context of the affected site would be statewide. For purposes of Section 106, the determination of effect would be *adverse effect*.

Beneficial impact — The site would be stabilized. For purposes of Section 106, the determination of effect would be *no adverse effect*.

Major: Adverse Impact — The impact would affect an archeological site with the potential to yield important information about human history or prehistory. The historic context of the affected site would be national. For purposes of Section 106, the determination of effect would be *adverse effect*.

Beneficial impact — Active intervention would be taken to preserve the site. For purposes of Section 106, the determination of effect would be *no adverse effect*.

Impairment: A major, adverse impact to a resource or value whose conservation is (1) necessary to fulfill specific purposes identified in the establishing legislation or proclamation of

Bighorn Canyon; (2) key to the natural or cultural integrity of the park; or (3) identified as a goal in the park's master plan or other relevant NPS planning documents. Project inventories and mitigation would still be conducted. However, without a systematic monitoring program and given the potential access concerns, there would continue to be a risk of some unavoidable adverse impacts.

Impacts of Alternative A: Reinstate PWC Use under a Special Regulation as Previously Managed

Analysis. PWC users would have access to unknown archeological and submerged cultural resources under this alternative. Of the archeological sites and features currently listed on the National Register of Historic Places, none are within the project area being evaluated. Submerged resources are undocumented, although they are known to exist prior to the completion of Yellowtail Dam and the filling of Bighorn Canyon. Given the depth of the water throughout Bighorn Canyon, damage to submerged resources is unlikely.

Potential impacts directly attributable to unrestricted PWC use are difficult to quantify. The most likely impact to archeological sites would result from PWC users landing in areas otherwise inaccessible to most other national recreation area visitors and illegally collecting or damaging artifacts. According to park staff, looting and vandalism of cultural resources is not a substantial problem. A direct correlation of impacts attributed to PWC users is difficult to draw, since many of these areas are also accessible to backcountry hikers or other watercraft users. Under this alternative the low number of PWC users within the national recreation area would have a minor adverse impacts on listed or potentially listed archeological resources.

Reinstating PWC use is not expected to negatively affect the overall condition of cultural resources because project-by-project inventories and mitigation would still be conducted.

Cumulative Impacts. PWC users, other boaters, and land-based user groups would have access to remote areas with potentially listed archeological sites. On a cumulative basis all visitor activities could result in minor to major adverse impacts on those resources that are readily accessible, due to the number of visitors and potential for looting or vandalism. Resources in more remote areas that are not as readily accessible to visitors would likely still experience minor adverse impacts on a cumulative basis, but to a lesser degree. All impacts levels would continue at existing levels.

Conclusion. PWC use within the national recreational area could have minor adverse impacts in the short and long term on listed or potentially listed archeological sites from possible illegal collection and vandalism. Cumulative impacts on archeological resources that are readily accessible could be minor to major adverse over the short and long term, due to the number of visitors and the potential for illegal collection or destruction.

Implementation of this alternative would not result in an impairment of cultural resources.

Impacts of Alternative B: Reinstate PWC Use under a Special Regulation with Additional Management Prescriptions

Analysis. PWC users would have access to unknown archeological and submerged cultural resources under this alternative. Submerged resources, while known to exist prior to the completion of Yellowtail Dam and the filling of Bighorn Canyon, are undocumented. Given the depth of the water throughout Bighorn Canyon, damage to submerged resources is unlikely. Submerged resources are undocumented,

although they are known to exist prior to the completion of Yellowtail Dam and the filling of Bighorn Canyon.

Impacts to archeological sites and features would be similar to those under alternative A. Under this alternative the low number of PWC users within Bighorn Canyon would have a minor adverse impacts on listed or potentially listed archeological sites. The South Narrows has not been evaluated for archeological or submerged resources; however, closing this area could have a beneficial impact on potentially listed archeological sites.

Cumulative Impacts. On a cumulative basis all visitor activities could result in minor to major adverse impacts over the short and long term on those resources that are readily accessible, due to the number of visitors and the potential for looting or vandalism. All impact levels would continue at existing levels, with lower impacts in the South Narrows.

Conclusion. Closing the South Narrows could have beneficial impacts on potentially listed archeological resources from possible illegal collection and vandalism. Cumulative impacts of other activities on archeological resources that are readily accessible could be minor to major and adverse over the short and long term, due to the number of visitors and the potential for illegal collection or destruction.

Implementation of this alternative would not result in an impairment of cultural resources.

Impacts of the No-Action Alternative: Allow No PWC Use

Analysis. Under this alternative PWC use would not be reinstated. Implementation of the no-action alternative would result in beneficial impacts over the short and long term on archeological sites or submerged features by reducing the potential for illegal collection or damage attributable to PWC users.

Cumulative Impacts. Even without the potential for PWC users to access remote areas, the effects of other watercraft users and land-based user groups would still have the potential for minor to major adverse cumulative impacts. On a cumulative basis potential visitor impacts from illegally collecting or damaging resources that are readily accessible would continue. Resources in more remote areas that are not as readily accessible to park visitors would likely still experience minor adverse impacts, but to a much less degree.

Conclusion. Prohibiting PWC use would have beneficial impacts over the short and long term on archeological sites. Adverse cumulative impacts from all visitor activities would be minor to major over the short and long term, depending on the accessibility of the resource and the potential for illegal collection or damage.

Implementation of this alternative would not result in an impairment of cultural resources.

SECTION 106 SUMMARY

This environmental assessment provides detailed descriptions of three alternatives (including a no-action alternative) and analyzes the potential impacts associated with possible implementation of each alternative. The analysis of potential impacts of personal watercraft at Bighorn Canyon National Recreation Area also considered access by other types of watercraft.

Visitors access areas of the national recreation area by many transport modes, including motor vehicles, boats of all types, hiking, and personal watercraft. Because of this diversity of modes of access, the

impacts on archeological cultural resources directly attributable solely to personal watercraft users are difficult to define. PWC users, other boaters, and land-based user groups would have access to remote areas with potentially listed archeological sites. On a cumulative basis all visitor activities could result in minor to major adverse impacts on those resources that are readily accessible, due to the number of visitors and potential for looting or vandalism. Resources in more remote areas that are not as readily accessible to visitors would likely still experience minor adverse impacts on a cumulative basis, but to a lesser degree. All impacts levels would continue at existing levels.

In cases where it was determined there was a potential for adverse impacts (as defined in 36 *Code of Federal Regulations* 800) to cultural resources listed on or eligible for listing on the National Register of Historic Places, the National Park Service would coordinate with the state historic preservation officers of Montana and Wyoming to determine the level of effect on the property, and to determine what mitigation would be needed.

Bighorn Canyon National Recreation Area staff would continue to educate visitors regarding archeological and ethnographic site etiquette to provide long-term protection for surface artifacts, architectural features, and traditional activities. If necessary, additional mitigation measures would be developed in consultation with the state historic preservation officers and concerned Native American tribes.

Concerned Native American tribes will receive copies of this environmental assessment for review and comment. This environmental assessment will also be sent to the state historic preservation officers for Montana and Wyoming and to the Advisory Council on Historic Preservation for review and comment as part of the Section 106 compliance process.

Pursuant to 36 *Code of Federal Regulations* Part 800.5, implementing regulations of the *National Historic Preservation Act* (revised regulations effective January 2001), addressing the criteria of effect and adverse effect, the National Park Service finds that the implementation of the plan in Bighorn Canyon National Recreation Area, with identified mitigation measures, would be beneficial, and would not result in any new adverse effects (*no adverse effect*) to archeological, submerged historic, ethnographic, or cultural landscape resources currently identified as eligible for or listed on the National Register of Historic Places.

SOCIOECONOMIC EFFECTS

This section summarizes the socioeconomic impacts associated with the proposed alternatives for PWC use in Bighorn Canyon National Recreation area. A detailed description of these impacts and a complete list of references are provided in the report "Economic Analysis of Personal Watercraft Regulations in Bighorn Canyon National Recreation Area" (LAW et al. 2002). A Benefit Cost Analysis of the alternatives is also included.

BENEFIT-COST ANALYSIS

The purpose of benefit-cost analysis is to determine whether an alternative would promote an efficient allocation of resources; this is whether the proposed action would generate more benefits than costs. These costs and benefits accrue directly to households that use personal watercraft, and indirectly to those who are affected by PWC use (e.g., those who would benefit from reduced noise). The resulting changes in PWC use could also impose costs on those who own or work for PWC-related businesses.

Even individuals who are not visitors of this national recreation area (i.e., nonusers) could benefit from the knowledge that the resources are being protected and preserved. In other words, they may hold positive "nonuse values" for protecting the national recreation area's environment. These nonuse values can stem from the desire to ensure others' enjoyment (both current and future generations) or from a sense that these resources have some intrinsic value. Evidence of such nonuse values for the protection of the national recreation area's resources is provided in the economics literature. Restrictions on PWC use in the national recreation area could therefore provide benefits to both users and nonusers in a number of ways by protecting the national recreation area's ecological resources.

For purposes of this analysis, six major affected groups have been identified and listed in table 29 along with the anticipated impacts of the proposed regulatory alternatives. The following definitions apply:

> *Consumer surplus* – the economic measure of net benefits that accrue to individuals from PWC use and the appreciation of the Bighorn Canyon's resources.
>
> *Producer surplus* – the economic measure of net benefits that accrue to businesses that sell or rent PWC and other related businesses. Producer surplus is generally equivalent to business profit.

Increases in consumer surplus and producer surplus represent benefits, while decreases in those measures represent costs.

This analysis of benefits is strictly qualitative since quantification of all benefits and costs was difficult with currently available data; therefore, the benefits are largely described in qualitative terms. The primary beneficiaries of alternatives B and the no-action alternative would be visitors to the national recreation area who do not use personal watercraft and whose experience would be adversely affected by the presence of personal watercraft. Average annual visitation to the national recreation area was approximately 237,000 people from 1997 to 2001. NPS staff estimate that the vast majority of recreational visitors come to the national recreation area for some form of water-based recreation, but according to NPS estimates, only about 0.68% of visitors are PWC users (LAW 2002).

Nonusers are also likely to benefit from the proposed measures. For example, individuals who do not visit the national recreation area can benefit simply from the knowledge that the natural resources of the national recreation area are being protected. Therefore, some of the benefit categories described below, in particular those associated with the preservation of unique national recreation area resources and ecosystems, may accrue in the form of nonuse values.

COSTS TO PWC USERS

Two groups of PWC users may be affected by the proposed regulations: users who have ridden in the national recreation area and users who ride personal watercraft in other areas outside the national recreation area where those displaced may decide to ride if PWC use in the national recreation area was restricted.

For PWC users who want to ride in the national recreation area in the future, prohibiting or restricting PWC use in the national recreation area could result in consumer surplus losses, an adverse effect. To the extent that individuals consider the utilization of other nearby PWC areas, the loss in consumer surplus associated with prescription PWC use in the national recreation area would be reduced.

TABLE 29: IMPACTS OF ALTERNATIVES ON USER GROUPS

User Group	Alternative A: Reinstate PWC Use under a Special Regulation as Previously Managed	Alternative B: Reinstate PWC Use under a Special Regulation with Additional Management Prescriptions	No-Action Alternative: Allow No PWC Use
1. PWC users	No change in consumer surplus.	Consumer surplus is expected to decrease very slightly for both current users and those who may wish to visit in the future as a result of the ban on PWC use at Yellowtail Wildlife Habitat.	Consumer surplus is expected to decrease for both current users and those who may wish to visit in the future as a result of the ban on PWC use in the national recreation area.
2. Other visitors or potential visitors: canoe users, anglers, other boaters, swimmers, hikers and other visitors	No change in consumer surplus.	Consumer surplus is expected to increase slightly for current users as a result of potential increased solitude, increased water quality, and decreased risk of accidents involving PWC. Consumer surplus is expected to increase for new visitors who would not have visited without restrictions on PWC use.	Increases in consumer surplus similar to, but larger than, benefits realized under alternative B. Consumer surplus is expected to increase for new visitors who would not have visited the national recreation area without a ban on PWC use.
3. Producers of PWC services: PWC rental shops, PWC sales shops, and other parts of the local economy providing services to PWC users	No change in producer surplus.	Most producers of PWC services would not experience a substantial change in producer surplus.	PWC rental shops are expected to experience a decline in producer surplus. Producer surplus for PWC dealerships is expected to decrease as a result of a decline in sales and servicing of personal watercraft. Other parts of the local economy such as hotels, restaurants, and gas stations located near the national recreation area will also experience a decrease in producer surplus.
4. Local residents of the area surrounding the national recreation area	No change in welfare.	Local residents who use personal watercraft may experience a slight decline in welfare due to location and timing restrictions on the use of PWC in the national recreation area. Local residents who do not use personal watercraft may experience a slight increase in welfare as a result of a potential decline in noise, increased water quality, and a decrease risk of accidents involving personal watercraft.	Local residents who use personal watercraft will experience a decline in welfare due to a ban of personal watercraft in the national recreation area Local residents who do not use personal watercraft may experience an increase in welfare as a result of a decline in noise, increased water quality, and a decrease in the risk of accidents involving personal watercraft.
5. Producers of services for visitors to the national recreation area who do not use personal watercraft	No change in producer surplus.	Small increase in producer surplus	Producer surplus is expected to increase because restrictions on PWC may result in an increase demand for other activities in the national recreation area, resulting in an increased demand for the provision of services related to these activities.
6. The general public who may care about the natural resources in the national recreation area even if they do not visit	No change in welfare.	May experience an increase in welfare as a result of enhanced nonuse values resulting from increased environmental quality, although the change in welfare is expected to be smaller than under the no-action alternative.	May experience an increase in welfare as a result of enhanced nonuse values resulting from increased environmental quality.

PWC users who currently ride in nearby areas could be displaced by riders from the national recreation area and would be adversely affected if these areas subsequently became more crowded. Although no studies were available that examine the impact of congestion on the value of a PWC trip, other recreation demand studies find that congestion lowers the value of a recreation experience.

The estimated impact of each proposed alternative on PWC users is discussed below.

Alternative A: Alternative A would have no effect on any of the user groups relative to conditions prior to the November 2002 ban on personal watercraft in NPS administered portions of Bighorn Canyon. Consumer surplus to PWC riders would remain unchanged.

Alternative B: Because the national recreation area would still be open to PWC with minor restrictions on use, the National Park Service expects this alternative to result in minor losses in consumer surplus relative to baseline conditions or alternative A.

No-Action Alternative: The no-action alternative would result in a continued prohibition on PWC use in the national recreation area. Visitors who use PWC exclusively would lose the full value of their consumer surplus associated with a visit to the national recreation area if PWC use is prohibited and they no longer make trips to Bighorn Canyon. To the extent that other suitable areas for PWC use are nearby, the consumer surplus losses would be mitigated by these other opportunities.

COSTS TO LOCAL AREA BUSINESSES

Bighorn Canyon National Recreation Area is remote. Along with agriculture and mining, tourism is the largest industry in the area. Billings is the largest town in the region, but the small towns of Fort Smith, Montana; Warren, Montana; Frannie, Wyoming; Deaver, Wyoming; Lovell, Wyoming; Byron, Wyoming and Powell, Wyoming are also within 75 miles of the national recreation area.

Due to the small number of PWC used in the national recreation area relative to other water vessels, the presence of other reservoirs and lakes within 200 miles of Bighorn Canyon that allow PWC use, and the diversity of recreational activities in the area, the PWC industry in the vicinity of Bighorn Canyon is relatively minor. According to NPS personnel, there are three businesses within a 100-mile radius that sell PWC. All three are located in Billings, Montana. The primary economic impacts associated with the proposed PWC restrictions would be potential reductions in the sales, profits, and employment of businesses that serve PWC users visiting the national recreation area. The total regulatory cost of each alternative would depend on how the affected individuals and firms responded to changes under the no-action alternative. To the extent that affected local retailers could provide substitute products and services, they might be able to reduce any negative impact on their profits. For instance, some current PWC users might continue to visit Bighorn Canyon to participate in other recreational activities, which would decrease the financial impact on local businesses. It is also possible that visitation by non-PWC users to the national recreation area would increase following prescriptions on PWC use if the prescriptions made park visitation more enjoyable for other users. The most popular visitor activity at the national recreation area is fishing and PWC regulations would not deter visitors from participating in this type of activity. Therefore no effects to lodging establishments, restaurants, or other tourism related businesses would be expected from PWC restrictions or a continued ban.

If PWC use decreases as a result of the regulations, then the suppliers of PWC sales and rental services would be directly affected. In addition, lodging establishments, restaurant, gas stations, and other businesses that serve PWC riders could experience a reduction in business from the proposed regulation.

Based on the existing data and interviews with local businesses, the National Park Service does not expect alternative A to result in revenue losses to firms, but alternatives B and C will result in reductions in PWC revenue. Under alternative C producer surplus losses are estimated to range from $2,530 to $19,420 for PWC sales/service and $1,520 to $3,380 for PWC rentals. For alternative B, estimated producer surplus losses range from $170 to $1,290 for PWC sales/service and from $80 to $170 for PWC rentals. The range of losses predicted for other business categories, which include restaurants and bars, groceries/take-out, gasoline and oil, and souvenir/retail shops is between $0 and $420 depending on the business category, the alternative, and the profit ratio used. Overall, producer surplus losses are estimated to be $4,280 to $24,860 under alternative C, $250 to $1,520 under alternative B, and $0 under alternative A.

Conclusion. Socioeconomic impacts would be negligible under all alternatives.

NATIONAL RECREATION AREA MANAGEMENT AND OPERATIONS

There are three full-time protection rangers and three seasonal protection rangers dedicated to enforce all regulations throughout Bighorn Canyon National Recreation Area. Daily boat patrols do not occur, with emphasis being placed on periods of higher watercraft use, such as summer holiday weekends and regular weekends. During this period one to two rangers throughout the day may be on the lake patrolling from one to three hours.

CONFLICT WITH STATE AND LOCAL PWC ORDINANCES AND POLICIES

Impacts related to conflicts with state and local ordinances have been analyzed qualitatively using professional judgment to define thresholds or impact magnitude.

Impacts of Alternative A: Reinstate PWC Use as Previously Managed under a Special Regulation

Analysis. PWC users at the national recreation area would be required to follow all applicable state boating regulations, as well as NPS regulations. Under this alternative NPS rangers would enforce all state boating regulations within the recreation area. There would be no conflicts between park regulations and state regulations. Adverse impacts for alternative A would be negligible since no conflicts with state regulations would occur.

Cumulative Impacts. Personal watercraft are prohibited at several location within the body of Bighorn Lake under this alternative as specified under the Superintendent's Compendium and described in the "Alternatives" section. Implementation of alternative A would not be in conflict with existing state policies or regulations. Cumulative adverse impacts would be negligible under this alternative since management of PWC use would not be in conflict with state or local regulations.

Conclusion. Under this alternative, management of PWC regulations within the national recreation area would include NPS and state regulations. Reinstated PWC use under alternative A would be managed as it was prior to the ban in November of 2002 and would not result in conflicts with state regulations. Therefore, adverse impacts (including cumulative impacts) would be negligible.

Impacts of Alternative B: Reinstate PWC Use under a Special Regulation with Additional Management Prescriptions

Analysis. PWC use under alternative B would be managed under current state boating regulations with additional management prescriptions included as a part of this alternative. The area south of the Narrows would be closed to PWC use and the Superintendent's Compendium would be revised to restrict operation of watercraft. The prescriptions are within the NPS legal mandate to regulate recreational activities under their jurisdiction, and there would be no conflict with state or other federal policies or regulations.

Cumulative Impacts. Personal watercraft are prohibited at several location within the body of Bighorn Lake under this alternative as specified under the Superintendent's Compendium and described in the "Alternatives" section. Implementation of alternative B would not be in conflict with existing state policies or regulations. Cumulative adverse impacts would be negligible under this alternative since management of PWC use would not be in conflict with state or local regulations.

Conclusion. PWC management prescriptions under alternative B would apply only within the recreation area. There would be no conflict with other federal, state, or local PWC regulations or policies, and adverse impacts would be negligible.

Impacts of the No-Action Alternative: Allow No PWC Use

Analysis. The National Park Service would take no action to reinstate PWC use within Bighorn Canyon National Recreation Area. The no-action alternative would not be in conflict with other federal or state regulations or polices.

Cumulative Impacts. Other areas surrounding Bighorn Canyon National Recreation Area where PWC use takes place are subject to state regulations and may also follow local policies and regulations. Under the no-action alternative, conflicts would not occur with state or local regulations or policies at surrounding reservoirs, as PWC use would continue to be allowed in these areas. Cumulative adverse impacts resulting from such conflict would be negligible.

Conclusion. Continuing the ban on PWC use within Bighorn Canyon would not result in conflict with state or local PWC regulations or policies at surrounding water bodies where PWC use occurs. Therefore, adverse impacts related to such conflicts (including cumulative impacts) would be negligible.

IMPACT TO PARK OPERATIONS FROM INCREASED ENFORCEMENT NEEDS

Impacts to park operations from increased enforcement needs related to PWC use have been analyzed qualitatively using professional judgment to define thresholds or impact magnitude.

Impacts of Alternative A: Reinstate PWC Use as Previously Managed under a Special Regulation

Analysis. Reinstating PWC use within the national recreation area would occur using existing NPS boat patrols, with the assumption that PWC users would sometimes operate illegally within the recreation area (such as violating flat-wake speed zones). Staffing needs would remain at current levels and enforcement requirements would not change.

Cumulative Impacts. Motorboat users, swimmers, PWC operators, and canoeists all use the reservoir shoreline. Park enforcement staff would continue to provide assistance to these user groups to resolve conflicts and ensure safety. Park operations and enforcement needs for these groups would be the same as for existing conditions.

Conclusion. This alternative would have negligible adverse impacts on park operations and enforcement would continue at current levels.

Implementation of this alternative would not result in an impairment to park operations.

Impacts of Alternative B: Reinstate PWC Use under a Special Regulation with Additional Management Prescriptions

Analysis. Reinstating PWC use within the recreation area with management prescriptions would require increased education and enforcement actions by park staff. It is assumed that some PWC users would operate illegally, and park staffing would continue at current levels.

Cumulative Impacts. Cumulative impacts would be similar to those described for alternative A. Non-PWC boating activity would continue to place higher demands on enforcement staff than personal watercraft. Additional education material or programs would be required to inform the public of new PWC management prescriptions.

Conclusion. Alternative B would have negligible to minor adverse impacts on park operations. Staffing would continue at current levels, though increased enforcement efforts would be required to implement additional prescriptions. Additional educational efforts would also be required to inform PWC users of new regulations.

Implementation of this alternative would not result in an impairment to park operations.

Impacts of the No-Action Alternative: Allow No PWC Use

Analysis. Continuation of the ban on PWC use within Bighorn Canyon would reduce potential conflicts between PWC recreationists and other user groups, but park staff would be required to increase visitor education and enforcement. Signs and information programs would be required at the existing launch areas to indicate PWC use restrictions. Enforcement actions to ensure compliance with PWC use restrictions would be completed using the existing irregular boat patrols, with the assumption that PWC users would sometimes operate illegally, either knowingly or unknowingly, within the recreation area.

Cumulative Impacts. Cumulative impacts would be similar to alternative A as non-PWC activities would continue. Enforcement would be conducted with existing staff and boat patrols.

Conclusion. This alternative would have minor adverse impacts on park operations. No additional staff, funding, or equipment beyond what has been requested would be secured to ensure compliance with the PWC ban and to regulate existing boating use. Staff would initially need to spend more time and effort educating visitors until they became fully aware of the PWC ban. Under the no-action alternative, it would be likely that some PWC users would operate illegally within the recreation area.

Implementation of this alternative would not result in impairment to park operations.

UNAVOIDABLE ADVERSE IMPACTS

Unavoidable adverse impacts are impacts that cannot be avoided and cannot be mitigated, and therefore would remain throughout the duration of the action. The following list describes potential adverse impacts related to the alternatives being considered:

- PWC use would cause pollutant emissions into lake water and air under alternatives A and B. These impacts would decrease in the long term due to the required improvements in engine emission technology.

- Under the no-action alternative, the small number of PWC users who could no longer ride within the national recreation area would be adversely affected.

LOSS IN LONG-TERM AVAILABILITY OR PRODUCTIVITY TO ACHIEVE SHORT-TERM GAIN

As noted above, some resources would be degraded to some extent through implementation of either alternatives A or B. Inadequate monitoring and inventorying of resource conditions combined with long-term unlimited visitor use, could reduce the relative availability of habitat areas for bighorn sheep.

IRREVERSIBLE OR IRRETRIEVABLE COMMITMENTS OF RESOURCES

Irretrievable commitments of resources are those that can be reversed, that is, the commitment of a renewable resource or the short-term commitment of any resource. These include the commitment of water quality and air quality by allowing all mobile sources desiring to do so, including personal watercraft, to continue using the national recreation area under alternatives A and B. The use of fossil fuels to power personal watercraft would be an irretrievable commitment of this resource; however, this use is minor adverse.

CONSULTATION AND COORDINATION

To initiate the public scoping process, the National Park Service issued a press release in February, 2002 notifying the public of the intent to draft an Environmental Assessment to determine whether to continue personal watercraft use at Bighorn Canyon National Recreation Area. Prior to the press release, 137 comments had been received regarding proposed actions regarding PWC. Additional comments were received in response to the press release.

The national recreation area received 126 postcards from citizens that indicated that PWC use should be legal on NPS waters wherever other watercraft are allowed. In addition, other correspondence voicing opposition to a personal watercraft ban was received, including a petition with 147 signatures from people opposed to a ban. Conversely, another 34 letters and emails from citizens cited safety, noise and environmental effects from PWC use as reasons to ban the activity from the national recreation area.

Agencies that sent correspondence regarding PWC use in Bighorn Canyon included the Wyoming Game and Fish Department, the U.S. Geological Survey, and the U.S. Forest Service. Local governments that responded included County Commissioners from Washakie and Bighorn Counties in Wyoming, and the mayor from the town of Lovell, Wyoming. Organizations that sent letters and/or background information regarding PWC use include the Personal Watercraft Industry Association, Bluewater Network, and the Science and Conservation Center.

The distribution list for this document includes federal, state, tribal and local agencies as well as adjacent landowners, interest groups and the public at large. The following is a representation of agencies and organizations that will review this Environmental Assessment.

Federal Agencies
U.S. Fish and Wildlife Service
Bureau of Reclamation, Montana Office
Bureau of Reclamation, Wyoming Office

State Agencies
Montana Fish Wildlife and Parks
Wyoming Game and Fish
Wyoming State Historic Preservation Office
Montana State Historical Preservation

Tribes
Crow Tribe - Division of Natural Resources

Counties
Carbon County Commissioners
Big Horn County Commissioners

Localities
City of Lovell, WY
City of Hardin, MT

Organizations
The Wilderness Society
Bluewater Network
National Parks Conservation Association,
Northern Rockies Regional Office
Personal Watercraft Industry Association

The National Park Service has determined that none of the alternatives are likely to adversely affect any of the listed species. The completed environmental assessment will be submitted to the U.S. Fish and Wildlife Service for its review. If the agency concurs with the finding of the National Park Service, no further consultation will be required. Similarly, it has been determined that none of the alternatives is likely to adversely affect any cultural resources. The completed environmental assessment will be submitted to the State Historic Preservation Offices of Montana and Wyoming for review and comment.

No formal consultation has occurred with the Native American tribes for this study.

APPENDIX A: APPROACH TO EVALUATING SURFACE WATER QUALITY IMPACTS

Objective

Using simplifying assumptions, estimate the minimum (threshold) volume of water in a reservoir or lake below which concentrations of gasoline constituents from personal watercraft or outboards would be potentially toxic to aquatic organisms or humans. Using the estimated threshold volumes, and applying knowledge about the characteristics of the receiving waterbody and the chemical in question, estimate if any areas within the waterbody of interest may present unacceptable risks to human health or the environment.

Overall Approach

Following are the basic steps in evaluating the degree of impact a waterbody (or portion of a waterbody) would experience based on an exceedance of water quality standards / toxicity benchmarks for PWC- and outboard-related contaminants.

1. Determine concentrations of polycyclic aromatic hydrocarbons (PAH), benzene, and methyl tertiary-butyl ether (MTBE) in gasoline (convert from weight percent to mg/L, as needed) and PAH in exhaust. The half-life of benzene in water is 5 hours at 25°C (Verschuren 1983; EPA 2001).

2. Estimate loading of PAH, benzene, and MTBE for various appropriate PWC-hour levels of use for one day (mg/day)

3. Find/estimate ecotoxicological and human health toxicity benchmarks (risk-based concentrations) (micrograms [μg]/L) for PAH, benzene, and MTBE.

4. Divide the estimated loading for each constituent (μg) by a toxicity benchmark (μg/L) to determine the waterbody threshold volume (L) below which toxic effects may occur (convert liters to acre-feet).

Estimated hydrocarbon (HC) emissions from personal watercraft and outboards will be substantially reduced in the near future, based on regulations issued by the U.S. Environmental Protection Agency and the California Air Resources Board (CARB) (see the estimated reductions in the "Water Quality" section of the "Environmental Consequences" chapter).

Assumptions and Constants

Several assumptions must be made in order to estimate waterbody threshold volumes for each HC evaluated. Each park should have park-specific information that can be used to modify these assumptions or to qualitatively assess impacts in light of park-specific conditions of mixing, stratification, and the characteristics of the chemicals themselves. The assumptions are as follows:

- BTEX (benzene, toluene, ethyl benzene, and xylene) are volatile and do not stay in the water column for long periods of time. Because benzene is a recognized human carcinogen, it is retained for the example calculations below and should be considered in each environmental assessment or environmental impact statement (Verschuren 1983; EPA 2001).

- MTBE volatilizes slightly and is soluble in water. MTBE may accumulate in water from day to day, but this is not factored into the calculation and should be considered qualitatively in the assessment.

- PAH volatilize slightly (depending on structure and molecule size) and may adhere to sediment and settle out of the water column or float to the surface and be photo-oxidized. They may accumulate in water from day to day, but this is not factored into the calculation and should be considered qualitatively in the assessment.

- The toxicity of several PAH increases (by several orders of magnitude) when the PAH are exposed to sunlight. This was not incorporated because site-specific water transparency is not known, and should be discussed qualitatively.

- The threshold volume of water will mix vertically and aerially with contiguous waters to some extent, but the amount of this mixing will vary from park to park and location to location in the lake, reservoir, river, or other waterbody. Therefore, although the threshold volume calculation assumes no mixing with waters outside the "boundary" of the threshold volume of water, this should be discussed in the assessment after the threshold volume is calculated. The presence or absence of a thermocline should also be addressed.

- Volume of the waterbody, or portion thereof, is estimated by the area multiplied times the average depth.

In addition to these assumptions, several constants required to make the calculations were compiled from literature and agency announcements. Gasoline concentrations are provided for benzene, MTBE and those PAH for which concentrations were available in the literature. Constants used are:

- Gasoline emission rate for two-stroke personal watercraft: 3 gal/hour at full throttle (CARB 1998)

- Gasoline emission rate for two-stroke outboards: estimated at approximately the same as for personal watercraft for same or higher horsepower outboards (80–150 hp); approximately twice that of personal watercraft for small (e.g., 15 hp) outboards. (Note: Assume total hours of use for the various size boats/motors, and that smaller 15 hp motors that exhaust relatively more unburned fuel would probably be in use for a much smaller amount of time than the recreational speedboats and PWC). This estimate is based on data from Allen et al. 1998 (Figure 5). It is noted that other studies may indicate different relative emission rates (e.g., about the same emissions regardless of horsepower, or larger horsepower engines having higher emission rates than smaller engines [CARB 2001]). The approach selected represents only one reasonable estimate.

- 1 gallon = 3.78 liters

- Specific gravity of gasoline: 739 g/L

- 1 acre-foot = 1.234×10^6 L

- Concentration of benzo(a)pyrene (B[a]P) in gasoline: up to 2.8 mg/kg (or 2.07 mg/L) (Gustafson et al. 1997)

- Concentration of naphthalene in gasoline: 0.5% or 0.5 g/100 g (or 3,695 mg/L) (Gustafson et al. 1997)

- Concentration of 1-methyl naphthalene in gasoline: 0.78% or 0.78 g/100 g (or approx. 5,760 mg/L) (estimated from Gustafson et al. 1997)

- Concentration of benzene in gasoline: 2.5% or 2.5 g/100 g (or 1.85×10^4 mg/L) (Hamilton 1996)

- Concentration of MTBE in gasoline: up to 15% or 15 g/100 g (or approx. 1.10×10^5 mg/L) (Hamilton 1996). (Note: MTBE concentrations in gasoline vary from state to state. Many states do not add MTBE.)

- Estimated emission of B(a)P in exhaust: 1080 µg/hr (from White and Carroll, 1998, using weighted average B(a)P emissions from two-cylinder, carbureted two-stroke liquid cooled snow mobile engine using gasoline and oil injected Arctic Extreme injection oil, 24-38:1 fuel:oil ratio. Weighted average based on percentage of time engine was in five modes of operation, from full throttle to idle).

- Estimated amount of B(a)P exhaust emissions retained in water phase = approximately 40% (based on value for B(a)P from Hare and Springier).

Toxicity Benchmarks

A key part of the estimations is the water quality criterion, standard, or toxicological benchmark for each contaminant evaluated. There are no EPA water quality criteria for the protection of aquatic life for the PWC-related contaminants (EPA 1999a). There are, however, a limited number of EPA criteria for the protection of human health (via ingestion of water and aquatic organisms or ingestion of aquatic organisms only). Chronic ecotoxicological and human health benchmarks for contaminants were acquired from various sources.

Ecotoxicological benchmarks for benzo(a)pyrene, naphthalene, and benzene are from *Toxicological Benchmarks for Screening Potential Contaminants of Concern for Effects on Aquatic Biota: 1996 Revision* (Suter and Tsao 1996). The ecotoxicological benchmarks for benzo(a)pyrene (0.014 µg/L) and benzene (130 µg/L) are Tier II Secondary Chronic Values in table 1 of Suter and Tsao (1996), which were calculated using methods in the Great Lakes Water Quality Initiative (EPA 1993). The ecotoxicological benchmark for naphthalene (62 µg/L) is the EPA Region 4 chronic screening value (table 3 of Suter and Tsao 1996). This screening value was chosen for use as a conservative mid-range value considering the wide range of chronic values for naphthalene (12–620 µg/L) shown in Suter and Tsao (1996). The ecotoxicological benchmarks for 1-methyl naphthalene (19 and 34 µg/L) are based on LC_{50} values of 1,900 and 3,400 µg/L for the marine invertebrate, Dungeness crab (*Cancer magister*), and the fresh water/estuarine fish, sheepshead minnow (*Cyprinodon variegatus*), respectively (USFWS 1987). The MTBE benchmarks of 18,000 and 51,000 µg/L are for marine and fresh water, respectively, and are based on the preliminary chronic water quality criteria presented in Mancini et al. (2002).

State water quality standards (including the numeric standards and descriptive text) must be reviewed and applied, as appropriate for each park being evaluated. The standards or criteria that fit the designated uses for the waters in the national recreation area must be used (for example, is it designated as a drinking water source or used only for support of aquatic life. This will determine which benchmarks are used: the "water plus organism" benchmarks or the "aquatic organisms only" benchmarks. The correct benchmark

must be used for either freshwater or marine/estuarine locations if there are different numbers provided for these two environments.

Following are the default toxicity benchmarks for the PAH, benzene, and MTBE having gasoline concentration information:

Chemical	Ecotoxicological Benchmark (µg/L)	Source	Human Health Benchmark[b] (µg/L)	Source
Benzo(a)pyrene	0.014	Suter and Tsao 1996	0.0044[b] 0.049[c]	EPA 1999a
Naphthalene	62	Suter and Tsao 1996	—	—
1-methyl naphthalene	19[a] 34[a]	USFWS 1987	—	—
Benzene	130	Suter and Tsao 1996	1.2[b] 71[c]	EPA 1999a
MTBE[d]	18,000 51,000	Mancini et al. 2002	13	CA DHS 2002

a. Based on LC_{50}s of 1,900 and 3,400 µg /L for Dungeness crab and sheepshead minnow, respectively (19 ug/L used for marine/estuarine calculations; 34 µg/L used for freshwater calculations).

b. Based on the consumption of water and aquatic organisms.

c. Based on the consumption of aquatic organisms only.

d. Ecotoxicological benchmarks, which are considered preliminary chronic water quality criteria, are 18,000 µg/L for marine and 51,000 µg/L for freshwater. There is no EPA human health benchmark, but the California Department of Health Services (2002) has established a primary maximum contaminant level (MCL) of 13 µg/L.

Example Calculations

Calculations of an example set of waterbody volume thresholds are provided below for the chemicals listed above together with their concentrations in gasoline and available toxicity benchmarks.

Loading to Water

Loadings of the five contaminants listed above are calculated for one day assuming 10 personal watercraft operate for four hours (40 PWC-hours), each discharging 11.34 L gasoline per hour and having concentrations in fuel or exhaust as listed.

Benzo(a)pyrene (from the fuel): 40 PWC-hrs × 11.34 L gas/hr × 2.07 mg/L = 939 mg

Benzo(a)pyrene (from the gas exhaust): 40 PWC-hrs × 1080 µg/hr × 1/1000 mg/µg × 0.40 = 17 mg

Total B(a)P = 956 mg

Naphthalene: 40 PWC-hrs × 11.34 L gas/hr × 3695 mg/L = 1.68×10^6 mg

1-methyl naphthalene: 40 PWC-hrs × 11.34 L gas/hr × 5764 mg/L = 2.62×10^6 mg

Benzene: 40 PWC-hrs × 11.34 L gas/hr × 1.85×10^4 mg/L = 8.39×10^6 mg

MTBE: 40 PWC-hrs × 11.34 L gas/hr × 1.10×10^5 mg/L = 4.99×10^7 mg

Loadings of contaminants from two-stroke outboards should be estimated based on the estimated loading based on the horsepower of the outboards involved (see "Assumptions and Constants" above) and the estimated hours of use, based on the types of boats and the pattern of use observed.

Threshold Volumes

Threshold volumes of water (volume at which a PWC- or outboard-related contaminant would equal the benchmarks listed above) are calculated by dividing the estimated daily loadings (mg of contaminant) for the number of operational hours (e.g., 40 PWC-hours) by the listed toxicity benchmark concentrations (µg/L), correcting for units (1 mg = 10^3 µg), and converting from liters to acre-feet (1 ac-ft = 1.234×10^6 L):

Protection of Freshwater Aquatic Organisms

Benzo(a)pyrene: 956 mg B(a)P × 10^3 µg/mg / 0.014 µg/L = 6.8×10^7 L or 55 ac-ft

Naphthalene: 1.68×10^6 mg naphthalene × 10^3 µg/mg / 62 µg/L = 2.71×10^7 L or 22 ac-ft

1-methyl naphthalene: 2.62×10^6 mg 1-methyl naphthalene × 10^3 µg/mg / 34 µg/L = 7.69×10^7 L or 62 ac-ft

Benzene: 8.39×10^6 mg benzene × 10^3 µg/mg / 130 µg/L = 6.45×10^7 L or 52 ac-ft

MTBE: 4.99×10^7 mg MTBE × 10^3 µg/mg / 51,000 µg/L = 9.78×10^5 L or 0.79 ac-ft

Based on these estimates and assumptions, 1-methyl naphthalene appears to be the contaminant (of those analyzed) that would be the first to accumulate to concentrations potentially toxic to freshwater aquatic organisms (i.e., it requires more water [62 ac-ft] to dilute the contaminant loading to a concentration below the toxicity benchmark). However, the threshold volumes are very similar for 1-methyl naphthalene, benzo(a)pyrene, and benzene.

Protection of Human Health

Benzo(a)pyrene: 956 mg B(a)P × 10^3 µg/mg / 0.0044 µg/L = 2.17×10^8 L or 176 ac-ft

Benzene: 8.39×10^6 mg benzene × 10^3 µg/mg / 1.2 µg/L = 6.99×10^9 L or 5,670 ac-ft

MTBE: 4.99×10^7 mg MTBE × 10^3 µg/mg / 13 µg/L = 3.83×10^9 L or 3,110 ac-ft (If the CA MCL of 13 µg/L for fresh water is used)

The California public health goal for MTBE is a drinking water–based MCL and is not as broadly applicable as the other criteria used in this analysis. However, it may be of interest, since MTBE is very soluble, and MTBE concentration could be an issue if the receiving body of water is used for drinking water purposes and MTBE is not treated. Using the numbers provided above, benzene would be the first PWC-related contaminant in these example calculations that would reach unacceptable levels in surface water; however, volatilization of benzene from water to air was not included in the calculation. MTBE would be the next contaminant to reach unacceptable concentrations. If human health water quality criteria for ingestion of aquatic organisms only were used for benzo(a)pyrene and benzene (0.049 µg/L and 71 µg/L, respectively), the corresponding threshold volumes would be 15.8 acre-feet and 95.8 acre-feet.

As a result of the estimated reductions in HC emissions (from the unburned fuel) in response to EPA regulations (listed above), additional personal watercraft and/or outboards may be used in the parks without additional impacts to water quality. For example, based on the expected overall reductions from EPA (1996a, 1997), up to twice the current number of personal watercraft/outboards may be used in a given area in 2012 without additional impacts to water quality over current levels. Effects on noise levels, physical disturbance, or hydrocarbon emissions that are products of combustion (e.g., B[a]P) may not be similarly ameliorated by the reduced emission regulations.

Application of Approach

Use of the approach described above for evaluating possible exceedance of standards or other benchmarks must be adapted to the unique scenarios presented by each park, PWC use, and waterbody being evaluated. *State water quality standards (including the numeric standards and descriptive text) must be reviewed and applied, as appropriate.*

Factors that would affect the concentration of the contaminants in water must be discussed in light of the park-specific conditions. These factors include varying formulations of gasoline (especially for MTBE); dilution due to mixing (e.g., influence of the thermocline), wind, currents, and flushing; plus loss of the chemical due to volatilization to the atmosphere (Henry's Law constants can help to predict volatilization to air; see Yaws et al. 1993); adsorption to sediments and organic particles in the water column (e.g., PAH), oxidation, and biodegradation (breakdown by bacteria). Toxicity of phototoxic PAH may be of concern in more clear waters, but not in very turbid waters.

The chemical composition of gasoline will vary by source of crude oil, refinery, and distillation batch. No two gasolines will have the exact same chemical composition. For example, B(a)P concentrations may range from 0.19 to 2.8 mg/kg, and benzene concentrations may range from 0% to 7% (2% to 3% is typical). MTBE concentrations will vary from state to state and season to season, with concentrations ranging from 0% to 15%. The composition of gasoline exhaust is dependent on the chemical composition of the gasoline and engine operating conditions (i.e., temperature, rpm, and oxygen intake). If site-specific information is available on gasoline and exhaust constituents, they should be considered in the site-specific evaluation. If additional information on the toxicity of gasoline constituents (e.g., MTBE) become available, it should be considered in the site-specific evaluation.

Lastly, results of the studies included in the collection of papers entitled "Personal Watercraft Research Notebook" provided by the NPS staff, can be used to provide some framework for your analysis. The following table summarizes some of the results presented in various documents on the concentrations of benzene, PAH, and MTBE.

POLLUTANT CONCENTRATIONS REPORTED IN WATER

Pollutant	Source(s)	Levels Found	
		"Lower Use" (e.g. open water, offshore locations; reduced motorized watercraft use)	**"Higher Use" (e.g., nearshore, motorized watercraft activity high)**
Benzene	*Lake Tahoe Motorized Watercraft Report;* several studies reported		
	1. U.S. Geological Survey	1. <0.032 µg/l	1. 0.13 – 0.33 µg/l
	2. Miller and Fiore	2. ≤0.3 µg/l	2. just over 1 µg/l
	3. University of California	3. <0.1 µg/l	3. 0.1 – 0.9 µg/l
PAH	A. Mastran et al.	A. All below detection limits (<0.1 µg/l for pyrene and naphthalene; <2.5 µg/l for B(a)P, B(a)A, chrysene)	A. Total PAH – up to 4.12 µg/l in water column; total PAH – up to 18.86 µg/l in surface sample at marina, with naphthalene at 1 µg/l; B(a)P – ≥2.3 µg/l
	B. Ortis et al.	B. Experiment #1 – 2.8 ng/l phototoxic PAH	B. Experiment #1 – ± 45 ng/l phototoxic PAH; 5–70 ng/L total PAH
MTBE	A. *Lake Tahoe Motorized Watercraft Report;* several studies reported		
	1. U.S. Geological Survey	1. 0.11–0.51 µg/l	1. 0.3–4.2 µg/l
	2. Miller and Fiore	2. ≤3 µg/l	2. 20 µg/l (up to approx. 31 µg/l)
	3. University of California	3. less than nearshore area	3. up to 3.77 µg/l
	4. University of Nevada – Fallen Leaf Lake	4. —	4. 0.7–1.5 µg/l
	5. Donner Lake (Reuter et al. 1998)	5. <0.1 µg/l	5. up to 12 µg/l (Dramatic increase from 2 to 12 µg/l from July 4 to 7)
	B. NPS, VanMouwerik and Hagemann 1999		
	6. Lake Perris	6. 8 µg/l (winter)	6. up to 25 µg/l
	7. Shasta Lake		7. 9–88 µg/l over Labor Day weekend
	8. Three-day Jet Ski event		8. 50–60 µg/l
	9. Lake Tahoe		9. often within range of 20–25 µg/l, with max of 47 µg/l

GLOSSARY

BTEX — benzene, toluene, ethylbenzene, and xylene

National Ambient Air Quality Standards (NAAQS) — Concentrations of criteria pollutants in ambient air (outdoor air to which the public may be exposed) below which it is safe for humans or other receptors to be permanently exposed. The *Clean Air Act* establishes two types of national air quality standards.

Primary standards set limits to protect public health, including the health of "sensitive" populations such as asthmatics, children, and the elderly. **Secondary standards** set limits to protect public welfare, including protection against decreased visibility, damage to animals, crops, vegetation, and buildings.

The EPA Office of Air Quality Planning and Standards has set national ambient air quality standards for six principal pollutants, which are called "criteria" pollutants. They are listed below. Units of measure for the standards are parts per million (ppm) by volume, milligrams per cubic meter of air (mg/m^3), and micrograms per cubic meter of air ($\mu g/m^3$).

NATIONAL AMBIENT AIR QUALITY STANDARDS

Pollutant	Standard Value[a]		Standard Type
Carbon Monoxide (CO)			
8-hour Average	9 ppm	(10 mg/m^3)	Primary
1-hour Average	35 ppm	(40 mg/m^3)	Primary
Nitrogen Dioxide (NO_2)			
Annual Arithmetic Mean	0.053 ppm	(100 $\mu g/m^3$)	Primary and Secondary
Ozone (O_3)			
1-hour Average	0.12 ppm	(235 $\mu g/m^3$)	Primary and Secondary
8-hour Average[b]	0.08 ppm	(157 $\mu g/m^3$)	Primary and Secondary
Lead (Pb)			
Quarterly Average	1.5 $\mu g/m^3$		Primary and Secondary
Particulate (PM_{10}) *Particles with diameters of 10 micrometers or less*			
Annual Arithmetic Mean	50 $\mu g/m^3$		Primary and Secondary
24-hour Average	150 $\mu g/m^3$		Primary and Secondary
Particulate ($PM_{2.5}$) *Particles with diameters of 2.5 micrometers or less*			
Annual Arithmetic Mean[b]	15 $\mu g/m^3$		Primary and Secondary
24-hour Average[b]	65 $\mu g/m^3$		Primary and Secondary
Sulfur Dioxide (SO_2)			
Annual Arithmetic Mean	0.03 ppm	(80 $\mu g/m^3$)	Primary
24-hour Average	0.14 ppm	(365 $\mu g/m^3$)	Primary
3-hour Average	0.50 ppm	(1300 $\mu g/m^3$)	Secondary

a. Parenthetical value is an approximately equivalent concentration.

b. The ozone 8-hour standard and the $PM_{2.5}$ standards are included for information only. A 1999 federal court ruling blocked implementation of these standards, which the Environmental Protection Agency proposed in 1997. The Environmental Protection Agency has asked the U.S. Supreme Court to reconsider that decision.

Nonroad Model — An air quality emissions estimation model developed by the U.S. Environmental Protection Agency to estimate emissions from various spark-ignition type "nonroad" engines. The June 2000 draft of the nonroad model was used to estimate air pollutant emissions from personal watercraft. It is available at <http://www.epa.gov/otaq/nonrdmdl.htm>.

Personal Watercraft (PWC) — As defined in 36 CFR 1.4(a) (2000), refers to a vessel, usually less than 16 feet in length, which uses an inboard, internal combustion engine powering a water jet pump as its primary source of propulsion. The vessel is intended to be operated by a person or persons sitting, standing, or kneeling on the vessel, rather than within the confines of the hull. The length is measured from end to end over the deck excluding sheer, meaning a straight line measurement of the overall length from the foremost part of the vessel to the aftermost part of the vessel, measured parallel to the centerline. Bow sprits, bumpkins, rudders, outboard motor brackets, and similar fittings or attachments, are not included in the measurement. Length is stated in feet and inches.

SUM06 — The cumulation of instances when measured hourly average ozone concentrations equal or exceed 0.06 part per million (ppm) in a stated time period, expressed in ppm-hours.

Thermocline — The region in a thermally stratified body of water that separates warmer, oxygen-rich surface water from cold, oxygen-poor deep water. In a thermocline, temperature decreases rapidly with depth.

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CARB	California Air Resources Board
CDHS	California Department of Health Services
CPFPWS	Coalition of Parents and Families for Personal Watercraft Safety
FFWCC	Florida Fish and Wildlife Conservation Commission
IWL	Izaak Walton League of America
NOAA	National Oceanic and Atmospheric Administration
NPS	National Park Service
NTSB	National Transportation Safety Board
ODEQ	Oregon Department of Environmental Quality
PWIA	Personal Watercraft Industry Association
USGS	U.S. Geological Survey

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As the nation's principal conservation agency, the Department of the Interior has responsibility for most of our nationally owned public lands and natural resources. This includes fostering wise use of our land and water resources, protecting our fish and wildlife, preserving the environmental and cultural values of our national parks and historic places, and providing for the enjoyment of life through outdoor recreation. The department assesses our energy and mineral resources and works to ensure that their development is in the best interests of all our people. The department also promotes the goals of the Take Pride in America campaign by encouraging stewardship and citizen responsibility for the public lands and promoting citizen participation in their care. The department also has a major responsibility for American Indian reservation communities and for people who live in island territories under U.S. administration.

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